Engineering Library

AUG 1 1939

Printed on thin paper for overseas circulation

The Engineer

VOL. CLXVIII.—No. 4360 28, ESSEX ST., STRAND, LONDON, W.C. 2 AUGUST 4, 1939

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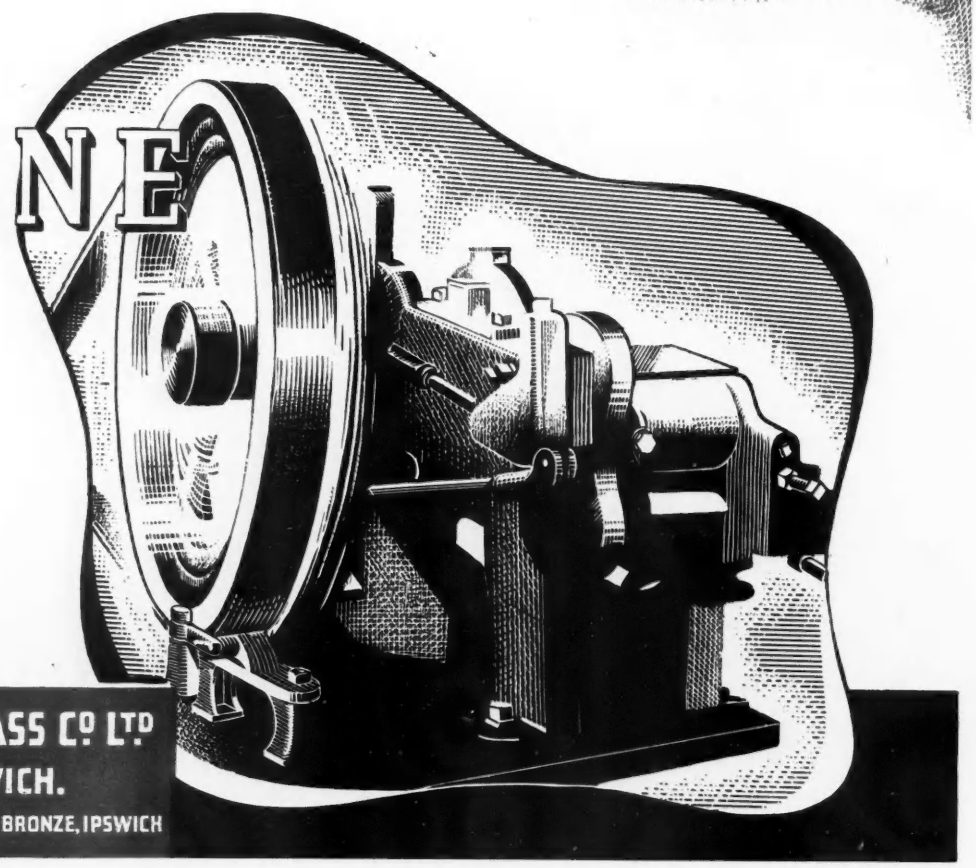

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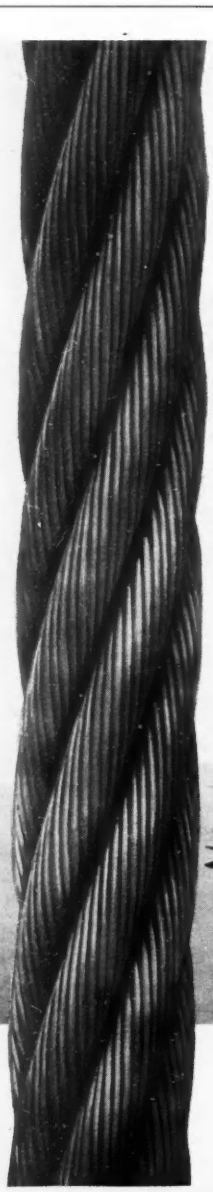

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The "Thetis" Inquiry

THE Tribunal of Inquiry under the chairmanship of Mr. Justice Bucknill, which is investigating the loss of the submarine H.M.S. "Thetis" in Liverpool Bay, adjourned on Thursday, July 20th, for a week, but in view of the Admiralty conference on salvage measures referred to in another Journal note, it did not resume its sittings until Friday, July 28th. At that meeting the Attorney-General, Sir Donald Somervell, stated that there had been, as all knew, a failure of the gear in the attempt recently made to raise the "Thetis," but that a further attempt would be made. Fresh and stronger gear would, he said, be required, and it was expected that the actual attempt would not be made until about the end of August. There would then be, he thought, some eight or ten tides in good weather to get the "Thetis" into shore, and it was possible that the submarine, if raised, might be beached rather after the middle of September. Mr. Justice Bucknill said that that being the case, he would fix the next meeting of the Tribunal at not before September 26th. That should, he said, give a full week before term, and the inquiry could be resumed at the first available date after that when the submarine had been raised—if she were raised. If the depth of water and the tides proved too strong for anybody to salve the ship, the Tribunal would then have to go on with the material it already had. If at all possible, he said, he would like to wait before concluding the inquiry, until they were in a position to get the evidence from the vessel herself. The inquiry was then adjourned, it being stated that more than two days' notice would be given of the next sitting.

The Asboth Helicopter

CERTAIN reports published in the daily Press regarding the Asboth helicopter do not appear to be strictly accurate in all respects. It is asserted that an Asboth helicopter is to be built for, or has been ordered by, the Air Ministry. We understand, however, that such a statement goes somewhat beyond the facts of the case. A private arrangement for the development or construction of a helicopter to the designs of Herr Oskar von Asboth has, we are informed, been made between that gentleman and the Blackburn Aircraft Company, and at the time of going to press the question of an order being placed by the Air Ministry is still under discussion. It may be recalled that soon after the war the Air Ministry actively assisted the late Mr. Louis Brennan to develop a helicopter, and subsequently offered a prize of £5000 for the production of a helicopter which would fulfil certain defined requirements. The prize was never claimed. Developments proceeded in another direction, namely, in that of machines such as the Cierva autogiro and the Hafner gyroplane, which differ from true helicopters by reason of the fact that, except at starting, their "windmills" are not directly driven by the engine, but are rotated by the forward motion of the machine through the air, which motion is imparted to it by a power-driven airscrew. The Asboth helicopter will, it is stated, be equipped with an engine of 180 H.P., which will drive two windmills mounted co-axially on a shaft extending upwards from the fuselage. The alignment of this shaft will be variable relatively to the body of the machine in order to allow control over the forward motion of the aircraft. The estimated maximum forward speed is given as being 100 m.p.h., and it is asserted that the machine will be capable of ascending to a height of 11,000ft. in 18 min. These figures may be compared with the performance of the Hawker "Hurricane," which is *not* our latest design of day-and-night, single-seater fighter. That machine has a maximum speed in excess of 335 miles an hour, and can climb to 15,000ft. in 6·2 min.

The Employment Returns

THE monthly returns of the Minister of Labour show that there has been an increase in the number of employed persons and a decrease in the number of unemployed persons in this country. It is provisionally estimated that at July 10th last the number of insured persons aged 16 to 64 in employment was approximately 12,912,000, an increase of 102,000 on the total for June 12th last, and 656,000 on July 18th, 1938. At July 10th, 1939, the numbers of unemployed persons on the registers of employment exchanges were 1,013,636 wholly unemployed, 190,364 temporarily stopped, and 52,424 normally in casual employment, a total of 1,256,424, or 93,155 less than at June 12th, 1939, and 516,692 than at July 18th, 1938. The total comprised 953,859 men, 27,151 boys, 24,930 women, and 29,484 girls. During the month under review the improvement in employment was most marked in the distributive trades, the principal textile industries, engineering, shipbuilding and repairing, the iron and steel industries, and metal goods manufacture, transport industries, printing and bookbinding, certain food industries, agriculture and horticulture, and furniture manufacture. Of the 1,143,333 persons applying for benefit or unemployment allowances, 23 per cent. had been unemployed for twelve months or more, 65 per cent. less than six months, 56 per cent. less than three months, and 44 per cent. less than six weeks. During the five weeks ended July 24th last, the number of vacant situations notified by employers to the employment exchanges and juvenile employment bureaux was 326,704, while the number filled was 276,127. Between July 26th, 1938, and July 24th, 1939, nearly 2,918,900 vacant situations were filled.

Trade Forecast

POLITICS is still the over-riding factor in the world economic situation. In every important country, except America, rearmament is now the mainstay of economic activity, and under its influence the volume of business activity should, in the opinion of the Federation of British Industries, continue to expand for some months to come. This activity, by increasing the general purchasing power, is helping to bring revival in many industries not directly affected by the defence programme, notably the general consumption industries. Nevertheless, the present boom is still very lopsided; while some industries are enjoying a high level of prosperity, others, like private house building, are becoming more depressed. Private investment is practically at a standstill, and the prices of the primary raw materials on the average continue to decline. A problem which is causing difficulties is the absence of available reserves of skilled labour in certain armament industries, and the fear lest this situation, at a time of accelerated armament expenditure, may set in train an upward spiral of inflation in both wages and the prices of finished goods. This is specially important from the point of view of our export trade and balance of international payments. Should the increase in the defence programme lead to a further expansion of our imports, then, according to the *F.B.I. Business Barometer*, it will not be easy to prevent our balance of trade from becoming still more unfavourable.

A Railway Wages Increase

AT a meeting which took place in London on Friday, July 28th, the managers of the four main line railways, informed the representatives of the three railway trade unions that in response to the representations which were made by the unions at a meeting which was held on June 30th, the railway companies had decided to increase the minimum rate of pay for adult male conciliation staff to 45s. per week, as from the beginning of the first full pay period following July 29th. This will have the effect of raising the lowest current rate from 43s. to 45s. per week, and the lowest base rate from 41s. to 45s. per week. In taking this course, the companies stated that they had been influenced by the opinions which were expressed by the Railway Staff National Tribunal in its decision issued in February, 1939. In that decision the Tribunal expressed regret that a general improvement, involving necessarily a great extra annual cost, could not be properly recommended at a time when traffic receipts, and still more net earnings, had fallen so greatly, and when the movement was still downwards. The Tribunal expressed the view, however, that a strong case had been presented for making an increase upon the lowest rates a first claim, as soon as the financial position made any substantial concession possible. In announcing the decision, which immediately benefits over 15,000 men, and will ultimately benefit a much larger number if there is a fall in the cost of living, the companies pointed out that although the trend of traffic receipts was now upwards and the net revenue for the past half-year showed an increase of £1,896,000, there was a decrease in revenue of about £2,750,000 in net revenue compared with 1937, the year in which it was decided to terminate percentage deductions, restore standard conditions, and grant certain improvements in rates of pay and conditions of service.

Royal Air Force Technical Branch

ON Tuesday, August 1st, it was officially announced by the Air Ministry that the Air Council has reached the conclusion that it is in the interests of the efficiency of the Royal Air Force that a Technical Branch, as distinct from the General Duties Branch, should be formed for engineering, armament, and signals duties. At the outset the new Technical Branch will comprise officers with specialist qualifications, who will be permanently transferred or temporarily attached from the General Duties Branch. Future entrants will, it is announced, in the main, be obtained from the following sources:—University graduates preferably with honours degrees in engineering or natural science who have completed a whole-time course at a recognised university; engineering students who have gone from school to a good engineering works and, in addition to obtaining at least three years' practical experience, have continued their technical education up to the standard of a second-class honours degree or gained an equivalent diploma from a technical college or qualified for membership of a professional institution; and engineers who have acquired theoretical knowledge up to university degree standard and have then had practical experience in a good engineering works. Ability to fly as a pilot will not be an essential condition of entry into the Technical Branch, but in the selection of new entrants previous flying experience in University Air Squadrons or in the Royal Air Force Volunteer Reserve will be taken into account in a candidate's favour. Technical Officers who comply with the medical standards will be encouraged to fly as pilots and to reach at least the standard of civil "A" licence pilots, and a proportion of these officers will be trained on service types and kept in flying practice. An announcement of the conditions of service in the new Technical Branch will be made at an early date.

A Further Railway Wage Demand

ON Tuesday, August 1st, the Associated Society of Locomotive Engineers and Firemen announced that a full statement of its case for an increase in wages had been forwarded to the railway general managers and the Ministry of Labour. This statement is taken to indicate that the policy decided upon is to withdraw labour upon a date yet to be fixed. Plans for action have, it is understood, been made and the permanent officers of the organisation are being advised of these plans. The claim of the Associated Society, together with that of the other two railway trade unions, came before the independent Tribunal in February last under the chairmanship of Sir Arthur Salter. The claims then put forward by the National Union of Railwaymen, the Associated Society of Locomotive Engineers and Firemen, and the Railway Clerks' Association were considered by the Tribunal, and with the exception of findings in respect of the claims of the National Union of Railwaymen, with regard to Sunday pay and duty spread-over, were rejected by the Tribunal on account of the financial position of the railway companies. At the same time, the Tribunal expressed the view that a case had been made out for an increase of the lowest rates as soon as it was possible for the railway companies to make any concession. Such a concession has just been made in the case of the workers in the conciliation grades, and is referred to in another Journal note. No statement had been issued on Wednesday with regard to the reply of the railway managers to the statement handed to them on Tuesday by the Associated Society of Locomotive Engineers and Firemen.

The Salvage of H.M.S. "Thetis"

As recorded in last week's Journal, a conference of all parties engaged in the work of salving H.M.S. "Thetis" took place at the Admiralty on Thursday, July 27th. Representatives of Cammell Laird and Co., Ltd., and the Liverpool and Glasgow Salvage Association were present, and the Third Sea Lord and Controller, Rear-Admiral Bruce Fraser, presided. According to a statement issued after the conference, the salvage operations are to be resumed, and the work will continue under the direction of the Liverpool and Glasgow Salvage Association. It is expected that about two to three weeks will elapse before the next attempt is made to lift the submarine. Meanwhile the salvage ship "Zelo" has returned to Birkenhead in order that the appliances for securing the eight lifting wires may be strengthened. As previously recorded in these columns, eight 9in. lifting wires are being employed, with the two ends, after being passed below the hull of the sunken vessel, attached to the "Zelo." In the last attempt it was found that the tidal streams are very strong, and that they differ on the surface and at the bottom of the sea, where the hull is resting. The strength and difference in direction of the tides, makes it extremely difficult to keep the lifting wires clear of each other while they are being rove, and, moreover, prevents the divers from checking the exact position of the wires below the ship when they are being "pinned down" at low water. Also twisting moments are introduced which cause the load to be unequally borne. It has now been decided to strengthen each of the securing arrangements on the "Zelo" in such a way that it can withstand the full breaking stress of the lifting wire. While this work is being carried out at Birkenhead, four of the lifting wires are being left in position under the "Thetis," two forward and two astern, together with the moorings laid down for the "Zelo," the wires and moorings being buoyed so that when the work is resumed they can be picked up quickly.

A History of Rotary Engines and Pumps

PART II.—No. II

(*Continued from page 92, July 28th*)

MODERN ROTARY PISTON MACHINES

1937 : *Keelavite.*—The design of a pump made by Keelavite Rotary Pumps and Motors, Ltd., of Coventry, is shown diagrammatically in Fig. 7. There is a cylindrical outer case A, within which there runs a rotor B carrying rotary blades C. These blades, which fit closely in recesses in the rotor, are so controlled by planetary gearing, as shown dotted in the drawing, that they retain a fixed angular relationship with the casing. A stationary abutment E blocks the working annulus

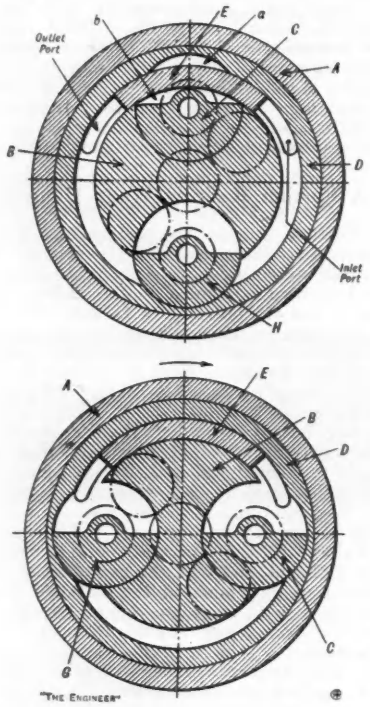


FIG. 7—DIAGRAM OF PUMP—KEELAVITE

over a short arc and the blades pass the abutment owing to their withdrawal into the rotor. Surrounding the rotor and passing behind the abutment there is a ring D which turns with the rotor and which has part-circular recesses to accommodate the blades. The inlet and outlet ports are placed one on each side of the abutment and it is clear that as the rotor turns fluid will be continuously delivered at a theoretically invariable rate.

It has already been remarked that the design of several modern machines appears to be based upon that of very much older devices and that the

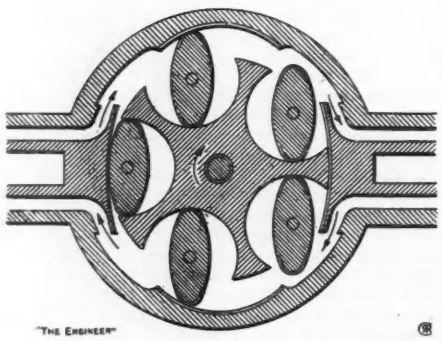


FIG. 8—BROOMFIELD AND LUCKCOCK—1825

incorporation of some usually quite simple improvement has converted an impracticable machine into a reliable and valuable article. The Keelavite pump provides a case in point. We do not know whether its inventor was aware of the machine proposed by Broomfield and Luckcock in 1825 (see article No. V of the first part of this series), but it is clear on comparison that the general principle of action is the same. In the older machine, however, the surrounding drum D is absent and as a result of its absence a number of defects become apparent. It is worth comparing the two machines to show what defects a rotary can suffer from and the manner in which they can be overcome. The drawing of the Broomfield and Luckcock machine is reproduced from the first part of this series in Fig. 8. Its blades had the same action as those of the Keelavite pump, but were differently shaped so that two inlet and two outlet ports were required. It will at once be observed that the machine has only line seals to prevent leakage from the discharge to the suction side. The line seals occur at the points of contact of the blades with the casing, with the recesses in the rotor and with the abutments. The machine could not therefore have been used for high pressures. Moreover, considerable loads are thrown at certain points of the circuit upon the timing gears maintaining the blades in the correct angular position. As each blade passes under an abutment one part of its face is exposed to the delivery pressure, resulting, with reference to the blade under the abutment in the drawing, in an anti-clockwise torque ; whilst the other part of the same face is only exposed to the much lower suction pressure. The timing gear has therefore in this position to withstand the whole resultant torque, whilst in other situations the load upon it will be slight. Uneven wear is inevitable under such circumstances even if leakage or breakage does not occur.

On referring to the Keelavite design it will be found that carefully considered design has rid the machine of these defects. Owing to the presence of the surrounding drum it is possible to provide for area seals at all points. The blades do not actually run in contact with the recesses in the rotor and drum, but with very small clearances, and those recesses in the drum and rotor are formed in the same boring operation so that the clearances cannot be affected by machining errors. As the blades pass under the abutments they are relieved of the duty of maintaining the seal, since leakage is prevented at this point by a fine "area" clearance between the rotor body and the abutment. No torsional stress, then, can at this point of the circuit be thrown upon the timing gears. At other points in the circuit the pressure either acts across the whole diametral face of the blade, with no resultant torque, or upon a radial face, also resulting in no torque. In fact, at no moment are the timing gears required to resist any torque other than that resulting from fluid friction in the fine clearances. The actual pumping load is transmitted from the rotor through the blade shafts to the blades. The actual arrangement of a typical pump is shown in Fig. 9. Two units such as those described are arranged back to back on the same central rotor B, being held by four bolts which also clamp the drums D to the rotors. The blades C are carried on shafts running from side to side of the unit and the timing gears are arranged at one end. The whole of this assembly is encircled by the ring J fixed to the casing. Inlet and outlet ports are cut in this ring and the abutments are formed integrally with it. Several differing designs based upon the same principle have been developed by the company to suit particular duties. The machine is made as a pump, air compressor, and air motor. Graphs reproduced in Fig. 10 show the characteristics of a pump.

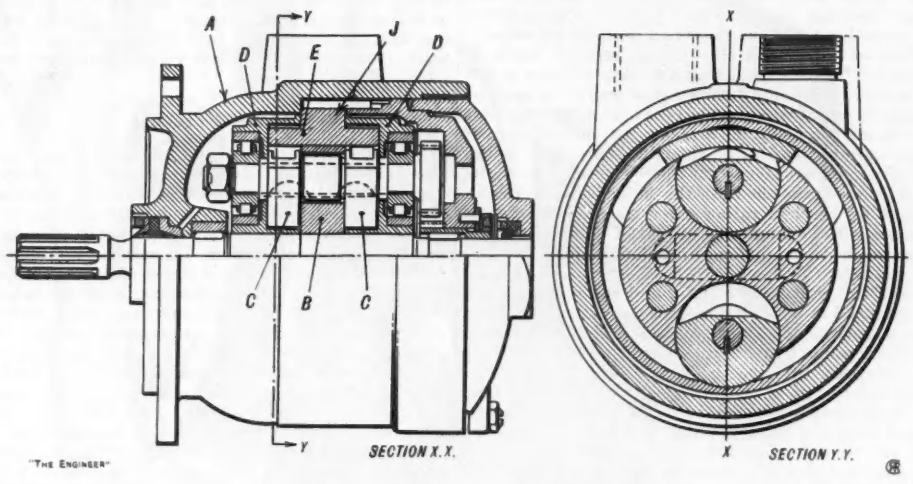


FIG. 9—SECTION THROUGH PUMP—KEELAVITE

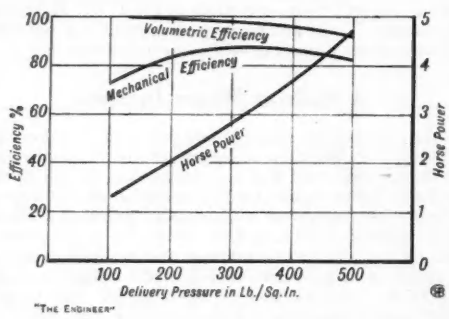


FIG. 10—PERFORMANCE OF PUMP—KEELAVITE

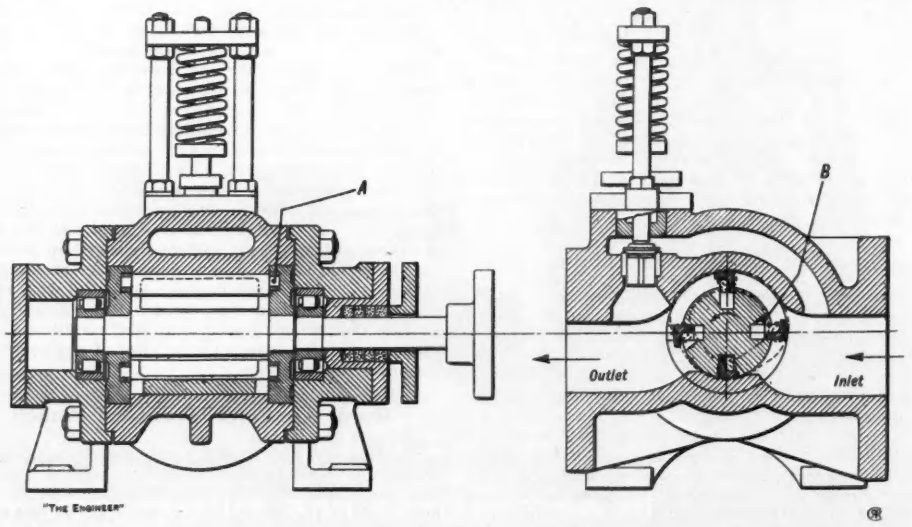


FIG. 11—ARRANGEMENT OF PUMP—CLARKE, CHAPMAN

1939 : *Clarke, Chapman.*—The firm of Clarke, Chapman and Co., Ltd., of Gateshead, has recently introduced a Rotary Piston pump particularly intended for pumping oil. It is made in sizes which a few years ago would have been considered very large for rotaries. The largest pump is able to deliver as much as 400 tons per hour—nearly 1500 gallons per minute. The design of these machines — Figs. 11 and 12 — is apparently simple, but much consideration has clearly been given it with the object of eliminating various defects that have made similar machines fail in practice in the past. Four blades are able to slide in slots in the rotor. Each blade is fitted with a

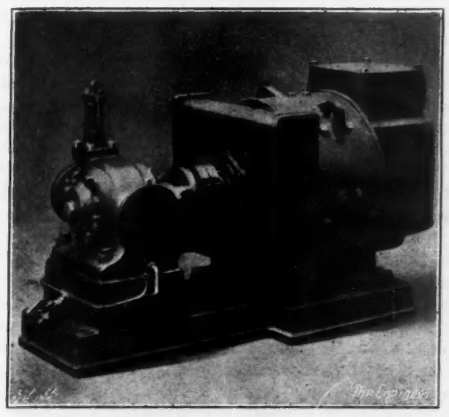


FIG. 12—ROTARY PUMP—CLARKE, CHAPMAN

pin at each end and the pins carry rollers A, which engage in cam grooves formed in cam plates fixed to the end covers. For running at high speeds and discharging against high pressures it is, as has been pointed out before, important that delivery should be uniform. In this machine the conditions necessary to achieve that result, as outlined in article No. IV of the first part of this series, have been met.[1] As each blade recedes into its slot the next behind takes up the delivery whilst the recession of the leading blade into its slot is compensated by the displacement from the slot through the channel B of an equivalent quantity of fluid. On the practical side there are a number of details worthy of notice in the design. The heads of the blades are formed to the same radius as the interior of the casing at a very small clearance from which they are required to work. At the sides, even

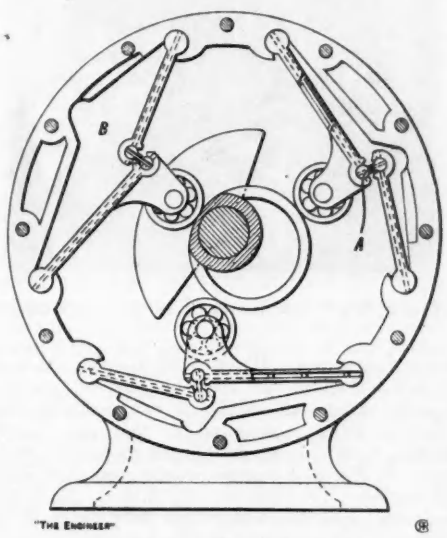


FIG. 13—SLEEPER AND MAHON—1901

when fully extended, the blades are supported over their full radial lengths by slot extensions in the end flanges of the rotor. Thus at all points area seals are interposed between the suction and delivery sides, whilst, since the blades are properly supported when extended, wear of the rear lip of each slot is avoided. When interposed between the suction and delivery sides the blades are not called upon to move radially. Only when they are no longer responsible for maintaining the seal do the cams come into action. In fact, the blades are moved only when tangential and radial pressures upon them are completely balanced. Wear of the blade guides and cams is thus very much reduced.

Pumps of this kind are claimed to show mechanical efficiencies up to 80 per cent. They will operate with suction lifts up to 25ft. depending on the viscosity of the oil and will discharge against pressures up to 250 lb. per square inch. Their qualities are claimed to make them suitable for pumping cargo oil, fuel oil, pressure lubricating oil, cooling oil, and, in fact, for oil pumping duties in general. The body and end covers are made of cast iron ; the rotor and shaft of 35-ton carbon steel ; the blades from high-class bronze chosen for its resistance to the corrosive effect of sulphur compounds in crude oils ; the blade rollers of hardened and ground steel ; and the roller tracks of cast iron.

EXCENTRIC MACHINES

Few novel arrangements of Excentric machines have been suggested in the present century, and, as far as we know, no modern pump or compressor operates on that principle. The last of the type seems to have gone out of production within the last few months.

1901/6954, *Sleeper and Mahon.*—The machine patented by Sleeper and Mahon promised little chance of success. Six arms were attached at intervals to the stationary cylindrical casing in such a way that they could rock to and fro—Fig. 13. At their outer ends they were attached

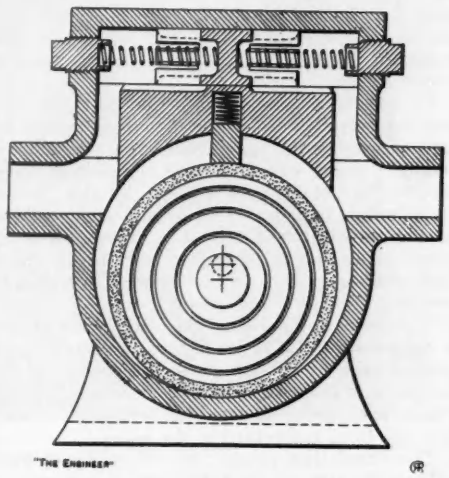


FIG. 14—BECKWITH—1919

in pairs by buckle joints to "floating" bars A. They thus enclosed chambers B, which could be enlarged and contracted by moving the arms in and out. That action was effected by an excentric on a shaft running through the centre of the cylinder and acting upon a ball bearing attached to the end of one of the arms in each pair.

1914 : *May Nelson.*[2]—In the *Mechanical Engineer* there is described a machine of American origin made by the May Nelson Manufacturing Company, of Washington, D.C. The arrangement first suggested by Trotter in 1805, and developed by Lamb in 1842[3] was adopted. An excentric drum was carried by plates at the ends of the working chamber, which were mounted on excentrics on the main shaft. The drum was slotted in the usual manner to admit the fixed radial abutment and a link and pins prevented it from rotating and relieved the abutment of the duty of restraining it. The fluid to be pumped was admitted through a pressure control valve to a space behind the end plate with the object of balancing the axial pressure.

1919/146,555 : *Beckwith.*—The machine patented by Beckwith was in general design a straightforward Excentric machine, with a spring-loaded reciprocating abutment—Fig. 14. The rotor was loosely mounted on a crank excentric to the interior periphery of the casing, "so as to roll around such periphery when the crank is rotated." A solid rubber tyre encircled the rotor in order to effect a better seal and water-sealing grooves were formed in the end of the rotor for the same purpose. The pump also had a spring-controlled pressure release valve between the suction and delivery ports so constructed that it would operate satisfactorily in whichever direction the machine was rotating.

The manufacture of pumps of this kind was taken up by the Avamore Engineering Company, Ltd., and the product was given the name "Squeegee." By October of the year in which it was patented it had been arranged to supply the pump in six standard sizes. A 1¼in. pump running at 1000 r.p.m. would deliver, it is said, 1000 gallons

FIG. 16—"BIROTOR" PUMP—METROVICK

per hour against 100ft. head at the expenditure of ¾ H.P. These figures suggest an overall efficiency of about 67·5 per cent. A larger pump, with 1½in. diameter branches, delivered 2000 gallons per hour against 100ft. head at the same speed and required 1¼ H.P. The standard range provided for capacities between 700 and 13,000 gallons per hour. Both the casing and the rotors were made of cast iron and the rubber tyre encircling the rotors seems to have been discarded at an early date, except perhaps when gritty materials had to be dealt with. The pump is described three years later in THE ENGINEER, and it is there mentioned as under manufacture by the Avamore Pump Company, Ltd., of Haslemere.

Metrovick.—Until a few months ago there was manufactured by the Metropolitan-Vickers Electrical Company, Ltd., of Manchester, under licence from the Société Anonyme Birotor, the simple pump shown in Fig. 16. The machine is actually of the Lamb type, with a radial abutment fixed to the casing and a slotted rotor drum. Instead, however, of causing the rotor to travel in an excentric path within the casing, both casing and rotor are caused to revolve each around its own axis, resulting in an identical relative motion. The casing, of course, becomes an outer drum. This drum was driven by gearing from a pinion shaft, as shown in the sectional drawing of a four-cell machine, Fig. 15. The inner drum was carried round by its connection through the radial blade to the outer drum. A suction port was placed in the outer drum immediately behind the blade and the incoming fluid was allowed to occupy the whole annulus outside this drum ; and an outlet port was formed in the inner drum, the fluid escaping from its interior through the hollow axle. This pump was made in capacities from 300 to 50,000

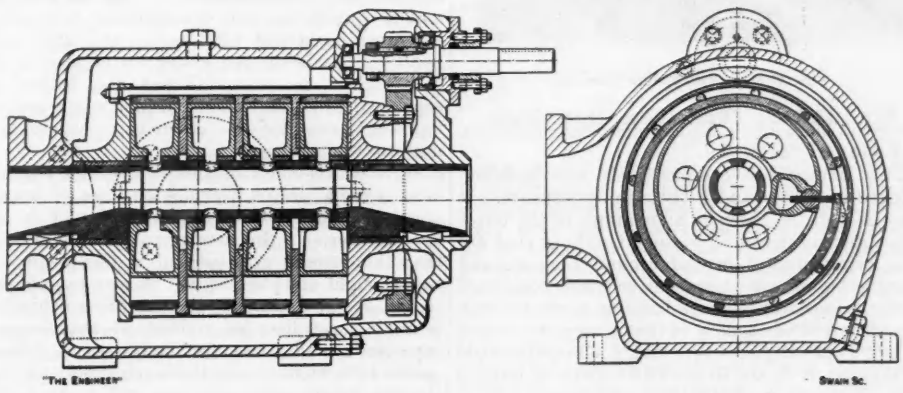


FIG. 15—FOUR-CELL BI-ROTOR PUMP—METROVICK

[1] Indeed, the pump is a practical realisation of the rudimentary machine shown in Fig. 20 of that article.

[2] *Mechanical Engineer*, Vol. XXXIV, page 408.

[3] See Article No. VII of the first part of this series.

gallons per hour discharging against pressures up to 300 lb. per square inch, and was considered suitable for a large variety of fluids, including highly viscous materials, such as treacle, liquid suet, molasses, soaps, and varnishes, and non-lubricating materials, such as petrol. It had the disadvantage, however, particularly in single-cell arrangements, that delivery was far from uniform, and it was probably in consequence not very satisfactory when operating against high pressures or pumping viscous fluids.

(To be continued)

Industries In and Around London

By JOHN HOLLOWAY

No. III—THE MANUFACTURE OF TOOTH PASTES

IN previous articles we have described the manufacturing processes involved in producing collapsible tubes, and also the type of machine used for filling these tubes with various compounds, such as tooth paste and shaving cream, and for closing and sealing the filling end of the tube to prevent leakage and deterioration of the enclosed substance. We shall now deal with a factory where these tubes and filling machines are in daily use for packing tooth paste and other compounds which are bought and sold to the public in any and every chemist shop.

As already stated, the object of these articles is not only to disclose the inner story of how this class of merchandise comes into daily use to serve the needs of countless millions of people in every civilised land, but also to show the engineering side of this enormous business, and particularly the *rôle* of the engineer and tool maker in almost every activity and service that add so much to the comfort of modern life.

With this end in view, we paid a visit to the

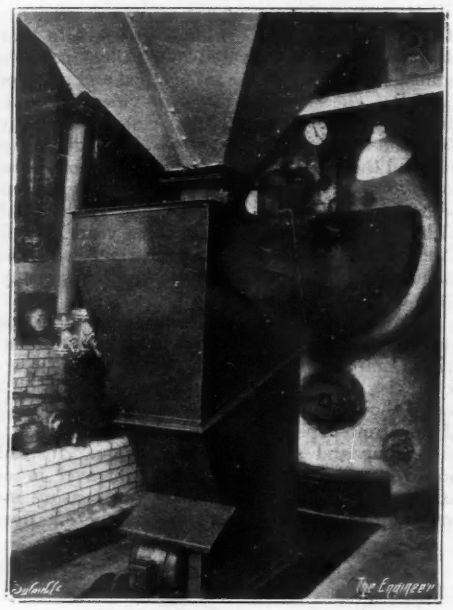


FIG. 1—STOKER-FIRED BOILER

factory of Macleans, Ltd., manufacturing chemists, at Brentford, Middlesex.

This factory is a comparatively new building, modern in design and artistic in appearance. It may in truth be taken as an example of the latest conception in design of factory buildings that are now being erected in and around London, and though we are not at present so much concerned with the appearance of the building as we are with the plant and equipment of the factory, it is worth noting in passing that this design shows the trend of thought in regard to the architecture of modern factories, particularly for light industries.

Boiler Plant

Some of the products manufactured by Macleans require heat at a uniform temperature during certain processes, and it is supplied to all the departments from the boiler house, where an efficient and interesting plant has been installed in well-ordered arrangement and lay-out. This plant consists of three No. 9 Halifax multitubular heating boilers by Hartley and Sugden, constructed for a working pressure of 100 lb. per square inch. The boilers supply hot water, but expressed in terms of evaporation, each has a normal output of 1550 lb. of steam per hour from and at 212 deg. Fah., the maximum capacity being 2000 lb. per hour. The heating surface is 320 square feet, and when the boilers are hand fired with solid fuel the grate area is 14·2 square feet. An efficiency of 70 per cent. is claimed by the makers at normal steaming rate.

These boilers are fitted with "Prior" underfeed mechanical stokers, with forced draught. The fuel used is washed singles, having the high calorific value of 13,500 B.Th.U. per lb. A view of one boiler front is given in Fig. 1. It will be seen that the fuel is fed by hopper to the mechanical stoker, the hopper being supplied with fuel by means of chain and bucket conveyor. The motor driving the screw conveyor feed to the furnace is also visible in the figure. It also drives the fan for forced draught.

To transfer heat from the boilers to the manufacturing plant in the factory a closed system of high-temperature water circulation has been adopted, rapid circulation of the water being effected by rotary pumps made by the Carrier Engineering Company. This system supplies all the heat required in the factory for manufacturing purposes, and for maintaining a uniform temperature of 65 deg. Fah. in the building during cold weather.

The circulating water is taken from the boiler at a temperature of 320 deg. Fah., corresponding to a steam pressure of 90 lb. per square inch absolute, and returns at an average temperature of 265 deg. Fah., thus showing 55 deg. Fah. reduction between delivery from and return to the boiler.

The circulating pump has a capacity of 1300 gallons of water per hour, and runs at 1400 r.p.m., being directly coupled to a 2 H.P. electric motor. To avoid the risk of heat trouble with the pump shaft, the glands and bearings are water cooled with water taken from a separate cold water system connected to a cooling tower. It may appear at first sight that the 2 H.P. driving motor is small for the work done, but it must be remembered that the difference in pressure between the inlet and discharge side of the pump is only 20 lb. per square inch, this being the difference between 90 lb. boiler pressure delivered to the pump and 110 lb. pressure at the discharge side into the circulating system.

For the normal running of the factory two boilers are generally found sufficient to meet all demands, and to spread the load equally these two boilers are cross connected with valves and pipes at a point that is below the lowest water level in the gauge glass, so that although the boilers are separately fired, they operate as one unit in supplying hot water for the circulating system at a uniform temperature.

In a boiler house of this description the pipe arrangement always becomes an item of importance, and calls for the special attention of the lay-out engineer. In this case there is ample evidence that the present arrangement is the result of a well-thought-out plan, as will be seen by reference to Fig. 2. To appreciate the main idea behind the plan, it must first be understood that separate pipe lines—and there are many—serve different parts of the factory, and that each supply pipe has its own return with only the unit to be heated interposed between the starting and the terminal points. The method adopted to meet these requirements is that known as "header distribution," and has been found to serve the purpose very satisfactorily. In operation, the system becomes quite simple. Firstly, water is delivered under pressure from the boiler unit to the rotary circulating pump, and is discharged at a slightly higher pressure to the header, whence it is distributed through valves and pipes to various parts of the factory. All the return pipes are likewise connected to headers, which in this case collect all the return water on its way back to the boiler for reheating. It will be seen in Fig. 2 that every pipe line has its own control valve, so that the heating system can be shut off from any part of the factory when necessary.

A further means of controlling the temperature of the circulating water after it leaves the boiler is by mixing a quantity of the return water with the supply, as it is discharged from the pump, the arrangement for doing so being seen in Fig. 1 at the left-hand side. The pipe and valve in the fore-front near the gauge is connected to the return water system, and should it become necessary to reduce the temperature of the supply water, it can be done by opening the valve and allowing the cooler water to pass through the bend attached to the supply pipe. In practice, this simple arrangement has been found a convenient method of balancing the temperature of supply water from the boiler.

Reviewing this system of heat transference, it must be recognised that it has a number of valuable advantages. One is that it obviates the loss of latent heat in steam and it eliminates entirely the use of steam traps and all the wasteful mess usually associated with their use in connection with steam heating systems. It also saves all the trouble and expense of collecting condensate from pipes and drains, and getting it back to the hot well or feed-water tank, and, above all, it practically removes the necessity of adding make-up to the feed water to compensate for the loss of condensate in drains and traps, which is generally present with steam heating. It is always a source of worry to the engineer in charge when he has to draw on company's mains for feed water make-up, particularly in districts where the water is hard—and London is among them—because he knows that unless there is a water softener or water purifier available, the scale deposit in the boiler will be increased with every gallon of hard water that is added. But with the closed high-temperature

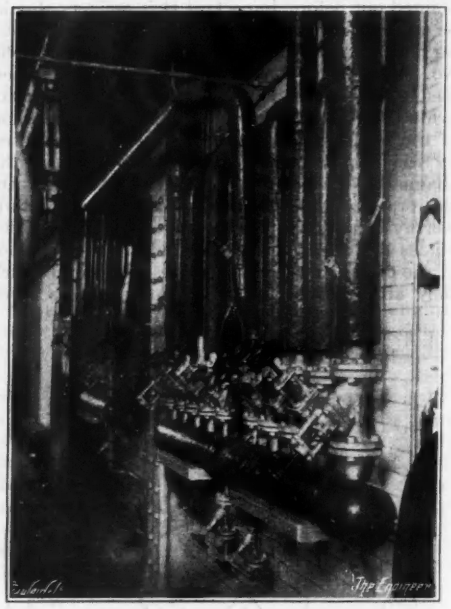


FIG. 2—PIPES AND HEADERS IN BOILER-HOUSE

water system many, if not all, of these troubles are absent. Perhaps the one thing to be guarded against to prevent having to use make-up feed water is leaky joints, and as they are usually visible, it should not be difficult to prevent leakage. In Fig. 2 it can be plainly seen that while all the pipe lines are heavily lagged, the joints between pipes and valves are fully exposed, so that any leakage would at once be seen.

Electric current for power and light used in the factory and office is taken from the mains of the electric supply company, and current is not generated on the premises. There is, however, a compressed air and vacuum pump station for supplying compressed air, and to create vacuum for vacuum powder filling machines. A view of this plant is given in Fig. 3. There are two SA 6 type Reavell air compressors and two Reavell vacuum pumps, each driven with Tex ropes from a 12 H.P. electric motor. The working pressure of the compressed air is 60 lb. per square inch. Standing adjacent to the compressors there is a Stern refrigerating plant for process cooling. Water for cooling the refrigerator condenser is taken from the cold water circulating system, which is connected to a Premier water cooling tower and pumping plant. This plant has a cooling capacity of 600 gallons per hour, and a tank to hold 10,000 gallons. All water

used for cooling purposes in any part of the factory is taken from this system, including the air compressors and vacuum pumps. No water is allowed to run to waste, but is returned by the system to the cooling plant.

THE FACTORY PLANT

It is well understood in these days that successful manufacturing in any branch of trade demands suitable and adequate organisation, and that as a rule the greater the number of pieces to be dealt with, the more perfect must the organisation be if delay and unprofitable expenditure is to be avoided. Generally speaking, there are two classes of organised control; one is mechanical and the other is human, but in some cases there may be a combination of both with the mechanical element predominating.

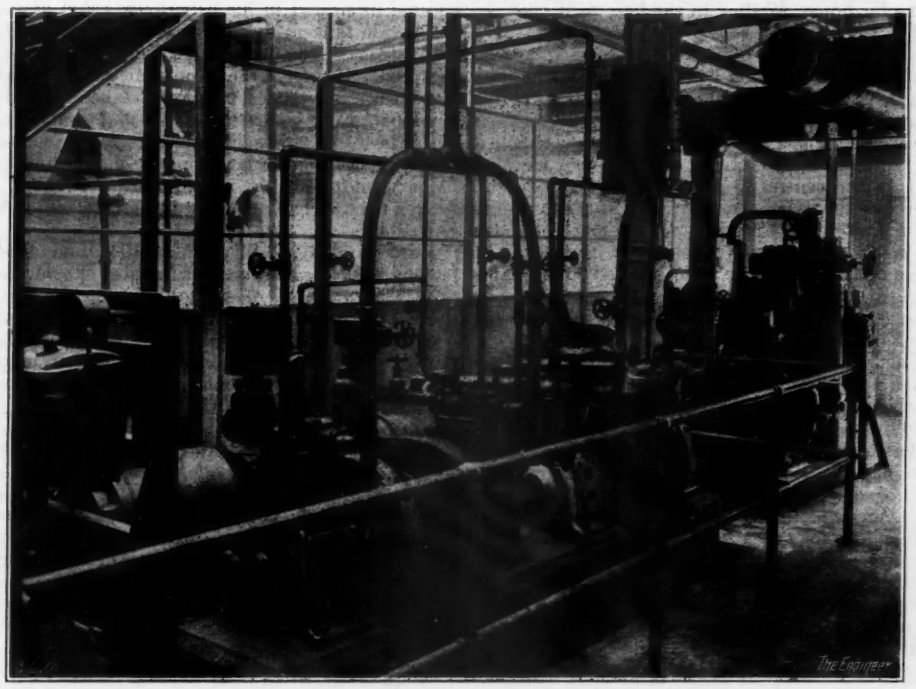


FIG. 3—COMPRESSED AIR AND VACUUM PUMPS

In factories in which continuous production is the rule and where the number of pieces to be handled is great, a maximum of mechanical control and a minimum of the human has proved most satisfactory and economical.

In Macleans' factory continuous production is the rule, and a maximum of mechanical control has been adopted. The number of pieces handled here runs into millions per week, but, even so, the mechanism of control functions so smoothly that when walking round one is hardly conscious of the enormous number of pieces being dealt with. It is no exaggeration to say that the whole factory is mechanised from top to bottom, and the carrying or moving of goods by employees is reduced to a minimum. There are automatic and semi-automatic filling and weighing machines, and packing and wrapping machines, with mechanically operated conveyors interspersed to give direction and govern the flow of goods in correct sequence from the moment the receptacle, whether it be tube, bottle, or canister, is placed on the filling machine to the time it passed to the packing room.

TOOTH PASTE DEPARTMENT

To follow and describe the process of manufacture of all the products in this factory would require a whole volume, but it may be possible to deal briefly with one of the popular lines for which the firm is known, say, tooth paste.

Preparation and mixing begins in the top floor, and is in charge of a qualified chemist, who controls the weight and treatment of each ingredient. The floor is equipped with sifting and mixing machines by the Pascal Engineering Company and W. R. Dell and Son. The latter machines are fitted with hot water jackets and heated from the high-temperature water circulation before described. Transference of liquid from the floor level to overhead drums is done with compressed air supplied by the compressor plant, and the liquid is run by gravity from the drums to the mixing or stirring pans, which stand immediately below. This arrangement is shown in Fig. 4 on page 130, and it will be noticed that the paddle shafts, for all three stirring pans are driven by one overhead shaft, which in turn is driven by belt from a main line shaft. After the mixing process is completed, the paste is taken by a power-driven screw conveyor to a three-roll mill to be reduced to a smooth velvet-like finish, and thence to the storing pan, where it is allowed twenty-four hours for maturing. When this process is completed the paste is ready for use, and the chemist's work is finished, but it has to be divided out into well-defined portions to be retailed to the public.

Tooth paste, as we have already seen, is now almost universally packed in the familiar collapsible tube, and it is the combined specialised service of several manufacturers, including engineers and chemists, that has made it possible for this and similar useful commodities to be served to the community with all the principles of hygiene rigidly observed, and at moderate cost.

This factory, like others, has been provided by engineers and metallurgists with means for quickly dividing the bulk manufacture of the chemist into small portions of exact quantity, within a couple of grains or so in weight. Various ways have been devised for doing this, but whatever means are adopted care has always to be exercised to prevent the paste becoming aerated. In this factory a closed system between the storing pan and the feed hopper on the filling machine has been found satisfactory, the transference being effected through a pipe line by the use of a "Mono" rotary pump, direct coupled to an electric motor. The consistency of the paste does not permit it to run freely, so that the ordinary type of rotary or reciprocating pump has difficulty in dealing with it, but the "Mono" pump, with its single rotor and stator of helical form, has a positive action that transfers the paste satisfactorily, and the filling machine hopper can be charged as required.

A part of the filling room is shown in Fig. 5 on page 130. Some detail of the filling and closing machine is clearly visible in the engraving and will need but little explanation. Actually, there are eight operating stations on the machine, all arranged in correct sequence and fully automatic in action. The attendant sitting at the front has a tray close to hand loaded with tubes, all prepared with caps screwed on, and the inside of each thoroughly cleaned with compressed air to remove any particles of dust before the paste is filled in. The tubes are placed in the cups shown on the machine, with the cap end at the bottom and the open end at the top, while they move along on the conveyor to each station on the machine. The first operation is filling the tube with the proper quantity of paste, filling always being started from the bottom and travelling upward so that the air in the tube is easily displaced. The tube is then moved by the endless conveyor to the next station, where the open end is closed flat, after which the conveyor moves it again to another station, where the flattened ends are folded. Similar movement takes place as each operation is completed until the last station on the machine is reached and the closed end of the tube has been folded and pressed close, folded again into a double fold, pressed close once more, crimped to lock the folds, and coded to identify the batch. At this stage the tube of paste is finished and ready to be packed into its carton, and as the circuit of the conveyor is completed the finished tube is automatically lifted off the machine and placed on a belt conveyor on which it travels to the girls seen sitting at the tables, who put it with its wrapper into the carton, and then allow it to be carried on a moving belt to the packers for despatch. Meanwhile other tubes have been similarly treated, for the attendant always keeps the endless conveyor on the machine loaded with tubes, and all the stations on the machine function simultaneously, so that actually one tube is completely finished at each actuation of the mechanism.

When running at normal speed each machine is timed for an output of filled and sealed tubes at the rate of forty-two per minute.

Every department in the factory is run on similar lines to the one just described. Machines and conveyors mostly perform all the arduous tasks and as a rule determine the rate of output. Every department has interesting features, particularly from the purely mechanical point of view, and as a study of modern factory lay-out. But they can now only be touched on briefly. In the department where the filling and packing of medicinal salts is carried out there are found machines by Southall and Smith, Ltd., arranged to deliver the salts and fill the container to a prescribed weight. There is a machine to enclose the containers in a cellophane wrapper at the rate of fifty per minute, after which they are carried along on a chain conveyor to be packed into large cardboard cartons, and these cartons, packed with dozens of the containers, are themselves allowed to slide along roller conveyors to an automatic gluing and sealing machine of the standard Knapp type, whence they are brought to the despatch department on a Dixon's platform conveyor. A view in this department is given in Fig. 6 on page 130.

There is another department fitted out with Pascal sifters and Micro pulverisers among other equipment. Here a powder is filled into glass bottles on the Albro vacuum filling machine, but firstly every bottle is passed through a British Miller hydro bottle washing machine and thoroughly cleaned and dried. After the bottle is filled it is passed to a Granfill screw capping machine and then to a Purdy sealing and labelling machine, and so on to the packers. The arrangement in this department is shown in Fig. 7, the filling machines being at the far end and the packing cartons at the front. How well ordered the arrangement is can be seen at a glance.

While the production side of the business has been so well studied and the skill of the engineer used to full advantage in maintaining both purity and volume of output, the welfare of the employees has also received due consideration. One valuable rule observed here is the system of serving meals and refreshment to the employees in relays, and thus avoiding a rush hour in the canteen, an arrangement that must surely be well appreciated.

BACTERIAL REDUCTION OF GARBAGE

INTERESTING tests have been made at Chicago in the treatment of dumped or tipped garbage—including paper and trash of all kinds—by a process which inoculates the mass with thermophilic bacteria. To the material deposited near the edge of the dump or bank by the city's trucks is added a mixture of thermophilic and thermogenic bacteria in limestone dust, peat, gypsum, molasses, and wood ashes. Then the whole mass is pushed over the bank by tractors with bulldozers or blades. In the bacteriological process the bacteria partially decompose the organic matter by feeding upon it, and then furnish heat sufficient to dry the product, while this heat is sufficient also to kill most of the bacteria that do not grow at high temperatures. As a result, the final product should be practically odourless and not very perishable. But on the basis of laboratory experiments and a year's operation at one of the city's dumps, the general conclusion is that while under special conditions and with proper apparatus thermophilic bacteria can be made to reduce garbage with a minimum of public nuisance, this does not apply under the conditions at the open dumps, so that the process as now practised is not to be recommended for garbage disposal. If the garbage was collected separately and kept free of paper, trash, ashes, and other refuse, it might be possible by the erection of several reduction plants to produce by the bacterial process a fertiliser which could be sold.

Refuelling in Flight

AS already reported in a previous issue, the British Atlantic air mail service is scheduled to start to-morrow, August 5th, when a "Cabot" class of Imperial Airways flying-boat is planned to make the ocean crossing after taking on the greater part of its fuel in the air. The route will be from Southampton to Foynes, Ireland, and thence, after refuelling, to Botwood, Newfoundland, Montreal, and New York. Each flying boat will carry a crew of five and a cargo of mail, but no passengers. Preparations have been made for some time for the refuelling operation to be carried out on the return journey at Botwood.

The process of transferring fuel from one machine to another in flight has been in course of development for nearly three years by Flight Refuelling, Ltd., in an experimental establishment at Yapton Aerodrome, Ford, near Arundel, Sussex, where the headquarters of the company is situated. Recently we were present during flights in which pilots and other members of the crew of Imperial Airways machines were being trained in the operation of the refuelling equipment, and we were able to inspect the procedure from the machine receiving petrol, representing the transatlantic flying-boat. We are indebted to Sir Alan Cobham, managing director, and Mr. Marcus Langley, of Flight Refuelling, Ltd., for the information upon which this article is based.

It is claimed that the method of transferring fuel in flight is applicable to all aircraft in which a long

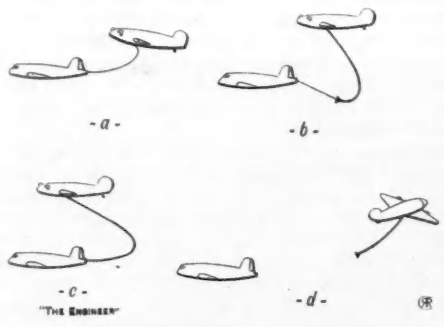


FIG. 1—DIAGRAM OF OPERATIONS

range or an increased payload is desirable, and that these important advantages are secured in every case. That is to say, Flight Refuelling, Ltd., maintain that refuelling in the air represents the best method of assisted take-off for all machines, but the advantages increase as the size of the machine increases. As outlined more fully below, the system enables the machine to have a high wing loading during the flight, but at the critical period of take-off the wing loading can be normal, or even reduced, so as to give an increased margin of safety. It is pointed out that a heavily laden machine which has been assisted off the ground by a catapult or inclined runway may be left in an extremely dangerous condition should one or more of the engines fail when the assistance is withdrawn. On the other hand, a refuelled machine need never be overloaded near the ground, because the operation of refuelling can be carried out at a safe height, thus providing time for some of the fuel to be jettisoned should it be necessary to land.

In the intensive development work which has preceded the latest design of equipment, methods have been found to overcome all the difficulties and criticisms put in the way of using the method. For example, we describe below a very complete equipment designed to eliminate all possible risks of fire caused by electrostatic discharges of any kind.

PROCESS OF REFUELLING

Briefly, the method consists, as perhaps is well known, in flying a tanking machine in formation with the machine to be refuelled. The receiving machine takes off light and lowers a weighted hauling line from a coupling in its tail. In one of several ways—not manually—the tanker makes contact with this line and brings the end on board. In the sketch, Fig. 1, reproduced herewith, the operations are shown. At *a* the hauling line is connecting the two machines, at *b* the hose pipe is drawn into the receiver coupling, and at *c* the position is shown with the hose connecting the two machines. This position is reached by removing the weight at the end of the hauling line, connecting the end to a nozzle on the hose pipe, and lowering it away from the tanker as it climbs to a position above, behind, and to one side of the receiving machine. By means of a windlass on the receiver, the nozzle is drawn into the tail coupling and the cocks are turned on, allowing the fuel to flow under gravity into the receiving tanks. When the operation is completed (Fig. 1, *d*) the receiver proceeds on its course and the tanker turns for home, winding in the hose as it goes.

The length of the hose is more than three times the vertical distance between the machines, so that it trails in a long flexible hairpin bend. Its length is more than sufficient to allow an ample margin for extreme bumps. As may be seen from the sketche, Fig. 1 *c*, the drag of the hose is applied on the longitudinal axis of the receiving machine and on the centre of gravity of the tanker, and therefore the flying characteristics of the machines are not altered at any time. If the machines have to break away in any emergency, the nozzle is arranged automatically to leave the coupling at a set load, but, of course, it can be instantaneously released at any time by the crew of the receiving machine.

For the whole operation of fuelling the time taken is very short, and, furthermore, the fuelling is effected while the receiving machine is proceeding on its course. Contact is normally made in less than five minutes, and with the size of hose designed for use with the Atlantic machines the rate of delivery is of the order of 120–150 gallons per minute. It has been arranged to transfer 800 gallons for the Atlantic service on each crossing, and therefore the total time taken should be less than fifteen minutes. For larger machines than the "Cabot" class boats larger hoses would be used, so that the total time would not increase.

It is pointed out that there is no difficulty in carrying out a formation flight between two aircraft, lasting ten, fifteen, or twenty minutes, giving ample time to deliver the necessary amount of fuel. Furthermore, we are informed that there is no difficulty in making the initial contact, and that the operations outlined above can be carried out successfully under all conditions in which the receiving aircraft would fly on its normal service.

HISTORICAL

The history of Sir Alan Cobham's experimental work in flight refuelling goes back over a period of ten years. Sir Alan had always been interested in the possibilities of flight refuelling as a means of assistance at the take-off. His experience of flying from temporary aerodromes and improvised runways in various parts of the world always impressed him with the difficulty and danger of taking-off in a heavily loaded machine. Great power was required to get off the ground, but at cruising speed less than half that power was sufficient. Therefore he formulated the idea that the aircraft should have a normal full-load take-off, and that when it was comfortably in the air it should receive the extra load in the shape of fuel, thus obtaining both an extended range and an increased pay load. The idea of flight refuelling as a means of keeping a machine in flight without landing has not so far been part of the programme, as the whole object of the experimental work is to enable high wing loading to exist while the machine is in the air, with low wing loading conditions at the take-off.

In 1932 initial experiments were carried out on two D.H.9 machines. In 1933 the Air Ministry became interested in his experiments and agreed to provide tankers for a projected non-stop flight to Australia. The machine for this flight was the Airspeed "Courier," the wing structure of which had been strengthened to allow a take-off weight of 3700 lb. to be increased to 5050 lb. by refuelling when the machine was in the air. Sir Alan successfully refuelled at Portsmouth and Malta, and the flight would probably have been successful if a broken throttle had not caused a forced landing to be made.

More data were collected in 1933 and 1934, leading to the conclusion that the hose should pass from the extremity of the tail of one aircraft to the nose of the other, so as to pass over no part of either aircraft. In order to ensure that this principle is carried out the tanking machine is arranged to formate on the receiving machine, the hose passing from the nose of the tanker to the tail of the receiver.

In October, 1934, Flight Refuelling, Ltd., was formed, and more experiments made, leading to the interest now taken by Imperial Airways, and the Air Ministry continued to collaborate by providing two "Virginia" machines for experimental work. A drawing-office was established and these experiments were made with properly designed hoses, nozzle, receiver coupling, and windlasses. In 1937 an Armstrong-Whitworth A.W.23 transport machine—the forerunner of the "Whitley"—was used to refuel a Handley Page 51—the forerunner of the "Harrow" machine. At present the aircraft available to the firm for experimental purposes and for the Transatlantic service are four "Harrow" machines and the A.W.23.

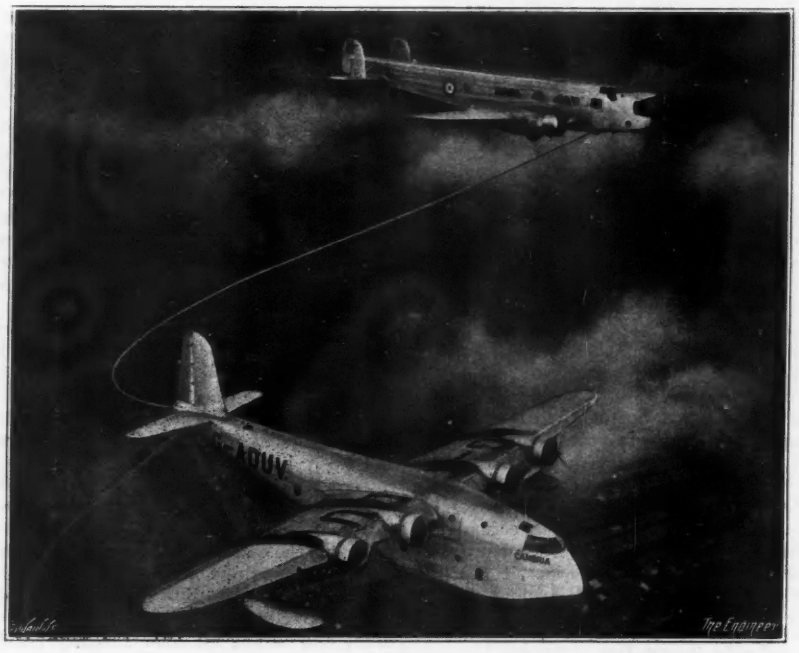


FIG. 2—REFUELLING TRIALS AT HAMBLE

In January, 1938, a programme of daily trials was carried out at Hamble with the A.W.23 refuelling the "Cambria" flying boat; trials were done in storm, fog, rain, and low cloud, proving that the operation was possible under any conditions in which it is possible to fly aircraft. One of these trials is illustrated in the engraving, Fig. 2. Furthermore, in June of that year flights were carried out daily throughout the month at 11 a.m. precisely to show that regular operation was possible.

The drawing-office and works have since been further enlarged and experiments have been con-

tinued simultaneously with the manufacture of equipment for the Atlantic service.

As the result of these experiments several other basic principles have been laid down by the firm. The most important are that in every case the receiving 'plane flies on an even course, the tanker formating upon it; no great skill is expected in the crew of the receiving aircraft; the nozzle on the hose pipe and the tail coupling on the receiver must form a petrol-tight joint which cannot jamb under any condition, and which will break away automatically in any emergency at a predetermined pull-off load; both skill and manual labour must be reduced to a minimum and the process mechanised and made as automatic as possible; and, finally, that all fire risks shall be eliminated.

In our inspection of the apparatus on our visit and during the test flight which we made, the whole process was seen to be performed with no difficulty and very rapidly. The accompanying half-tone engravings are reproduced from photographs taken on that occasion.

THEORETICAL CONSIDERATIONS

Throughout the history of aircraft design there has been a constant tendency to increase wing loadings. In pre-war days the limit was less than 10 lb. per square foot, but a few years ago it had risen steadily to 20 lb. per square foot, and has now reached 30 lb. per square foot or more.

In return for this increase in loading designers have been able to give ever-increasing speed, but they have paid the price by the raising of land speeds and the lengthening of take-off runs. To prevent deterioration at the low end of the speed range they have provided flaps, controllable pitch airscrews, ground boosting of engines, tricycle undercarriages, and so forth.

Increase of speed gained by the reduction of drag and resulting from these higher loadings has given air transport operators a great improvement in profit-earning capacity, gradually bringing them nearer the day when they will be free from the necessity for subsidies, and transformed into self-supporting, dividend-paying concerns. It has given military forces greater offensive and defensive power in increasing the speeds and ranges of action, together with the military loads which can be carried at those speeds.

Is there a limit to the increase in wing loading? In the past it has always been limited by ground conditions. Take-off, initial rate of climb, and landing speed have fixed the dimensions and weights of the aeroplane. But if those difficulties could be overcome, then undoubtedly much greater loads could be carried.

METHODS OF ASSISTING TAKE-OFF

Various methods of assisting heavily loaded aeroplanes into the air have been suggested and used at different times. An examination of the equation for the accelerating force during the take-off suggests the following classification :—

(1) *Improvement of Thrust*:

(*a*) Controllable pitch airscrews.

(*b*) Ground boosting of the power plant, including the use of high-octane fuel.

(*c*) Catapulting, inclined runways, &c.

(*d*) Mayo composite aircraft.

(2) *Reduction of Drag.*

Reduction of coefficient of friction by means of bogies on rails, concrete runways, &c.

(3) *Improvement of Lift.*

(*a*) Flaps of various designs, including mechanical variation of wing camber.

(*b*) Makhonine's spanwise variation of area.

(*c*) Use of slipstream and angle of thrust line relative to wing, according to the Crouch-Bolas patents.

(*d*) Mayo composite aircraft.

(4) *Reduction of Weight.*

Addition of fuel by the methods of Flight Refuelling, Ltd.

Several of these methods are to be found combined in the design of modern transport and military aircraft. Thus it is now usual to fit a modern air-liner with controllable pitch airscrews, ground boosted power plants, low drag flaps, to gain some advantage from the slipstream in improved lift, and to operate from aerodromes having concrete runways. It is only by these methods that wing loadings as high as those now used are possible. But these loadings are not the optimum when the machine is actually in flight.

Certain of the methods are not suitable for military aircraft, particularly those which imply the use of specially prepared aerodromes. Others are not particularly suitable for passenger purposes. For example, the acceleration of a catapult used for a passenger air-liner would have to be so low that its cost, weight, and dimensions would be prohibitive.

Another classification of the above methods divides them into two classes, those which are substantially safe and those which introduce a hazard. The exigencies of military services may demand the taking of certain risks which improve efficiency, but such action is rarely justified in civil aviation. Such a risk is run when the method assists the machine into the air, but leaves it in a dangerous condition should there be a sudden stoppage of one of the engines.

Although engine reliability has much improved in recent years, several accidents have lately been caused through engine failure. The condition of a heavily loaded aeroplane, having a low rate of climb, at the moment of withdrawing the assistance of ground boosting, catapults, runways, and so forth, is extremely hazardous. The failure of only one power unit will encroach upon its power reserve and reduce its rate of climb to a negligible or even negative quantity. The risk of such a failure varies in exact proportion to the number of power plants used, although the resulting embarrassment is correspondingly less.

It is obvious that low power loadings—that is to say, high-powered engines in relation to the weight—are not profitable, but low-power loadings have been forced upon aircraft designers by take-off and climb considerations. The ideal arrangement is that which gives a low power loading for the take-off and climb to a safe operating height, combined with a high and profitable power loading during the period of level "cruising power" flight. It is submitted by Flight Refuelling, Ltd., that this ideal is at least approached by the addition of the greater part of the fuel load at a safe altitude.

With regard to aerodrome sizes, suggestions have been made that aircraft efficiencies would improve if longer take-off runs were permitted. For longer take-off runs aerodrome sizes would have to be increased, and, furthermore, the I.C.A.N. regulations governing maximum take-off distance would have to be relaxed.

Already aerodromes must be placed far from centres of population, by reason of their size, and tens of thousands of acres of the best agricultural land has been sterilised by turning it into aerodromes. Aerodrome area increases as the square of the runway length, which in turn varies as more than the square of the wing loading, power remaining constant. The surrounding area free from obstructions, such as would hazard the heavily loaded machine in its initial climb, is similarly a high function of the wing loading. Thus, as is shown in a later paragraph, an aeroplane having a take-off run of about 300 yards at 30 lb. per square foot wing loading, would require over 500 yards at 40 lb. per square foot, over 800 yards at 50 lb. per square foot, and if a normal take-off were required at 60 lb. per square foot, the distance would be nearly 1300 yards. Doubling the wing loading increases the length of run by more than four times, and the area of a square aerodrome to give this run in any direction by more than sixteen times. For military aircraft using temporary aerodromes, this increase is obviously undesirable. Their aerodromes would in war time be vulnerable to attack, as has been demonstrated recently in the Spanish and Chinese warfare. In such conditions runways might be seriously damaged and a very restricted area left for take-off and landing.

Regarding the I.C.A.N. regulations, it is doubtful whether they should be relaxed. An increase in the permissible "unstick" distance would probably encourage the use of many aeroplanes having highly dangerous qualities, should one of their engines fail after the machine has left the ground. Whilst some relaxation has already been given, it would be undesirable to apply it to passenger machines, even though it includes a requirement to cover the maintenance of height after the failure of one or more engines. In any case the granting of a certificate of airworthiness to long-range aircraft taking advantage of this relaxation officially limits their use to certain airports.

It will be seen that the arguments outlined above all point to the method of fuelling in the air to increase payload or range with safety and efficiency.

REFUELLING AS APPLIED TO AN AIR-LINER

In order to examine the position, a hypothetical air-liner was designed by the company. It is a four-engined monoplane, having a tricycle undercarriage and twin rudders working in the slipstreams of the inner engines. The design is completely conventional, since it was wished to avoid the side-tracking of the main issue with discussion of any unconventional features. In order not to weight the argument in favour of flight refuelling, however, this aeroplane was given everything to favour a normal take-off. It has low power loading, constant speed airscrews, low drag flaps of the Handley Page slotted type, combined with ailerons which can be set down to a neutral angle of 20 deg.

Starting from a basic wing loading of 30 lb. per square foot and a power loading of 6·4 lb. per horse-power (take-off power), the all-up

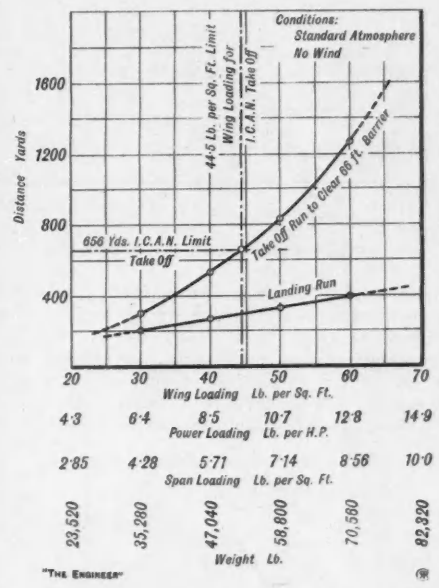


FIG. 3—TAKE-OFF AND LANDING RUNS

weight was increased in stages to give wing loadings of 40 lb., 50 lb., and 60 lb. per square foot. This procedure corresponds to the process of flight refuelling, all dimensions and the engine power remaining constant. The conclusions in the following paragraphs followed from the investigation :—

Performance.—The most pronounced effect of overloading is shown, as might be expected, in the length of the take-off run. In order to find the optimum weight which would allow the aircraft to comply with I.C.A.N. requirements, every possible benefit was given to the machine. Constant speed airscrews were assumed and various kinds of flaps were investigated. It was found that any flap having a high drag was very detrimental at

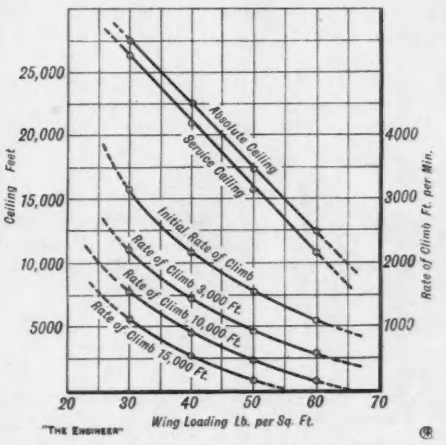


FIG. 4—RATES OF CLIMB AND CEILINGS

high loadings; in fact, under certain conditions the drag exceeded the thrust before the take-off speed was reached.

The take-off runs to clear a 66ft. barrier are given in Fig. 3, from which it can be seen that the maximum loading which satisfies the I.C.A.N. requirements was 44·5 lb. per square foot. It is not thought that a higher aspect ratio affects this loading appreciably, since the effect of induced drag is not considerable until the machine has left the ground.

With regard to rate of climb and ceiling, it is shown in Fig. 4 that the initial rate of climb at sea level drops progressively from 3180 ft. per minute at 30 lb. per square foot to 1108ft. per minute at 60 lb. per square foot. These high initial rates of climb are due to the use of 100 octane fuel from

the start of the take-off up to 1500ft. The rate of climb at the optimum take-off loading of 45 lb. per square foot was approximately 1840ft. per minute at sea level and 1175ft. per minute at 3000ft. These figures are satisfactory.

In Fig. 5 the top, cruising, and stalling speeds are shown. There is, of course, an increase in both

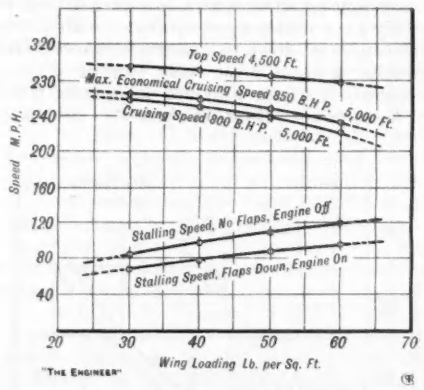


FIG. 5—COMPARISON OF SPEEDS

induced and profile drags as the weight is increased. Bristol "Hercules" sleeve valve engines were adopted in this hypothetical design. At what the manufacturers describe as "maximum cruising power for economical specific consumption" at 5000ft., the aircraft at 60 lb. per square foot still has a reasonable performance, and there

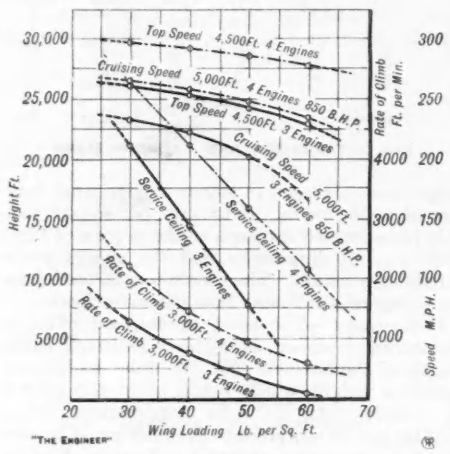


FIG. 6—PERFORMANCES WITH THREE AND FOUR ENGINES

appears to be no reason why the loading should not be made even higher. The ranges and corresponding payloads are calculated on the speeds corresponding to 800 B.H.P. per engine at 5000ft. They drop from 259 m.p.h. at 30 lb. per square foot to 224 m.p.h. at 60 lb. per square foot.

Performance After Engine Failure.—The performance was calculated for the case of one outer engine dead. The following effects were taken into account :—

(1) Reduction of available horse-power.
(2) Reduction in slipstream effect.
(3) Reduction in efficiency of remaining airscrews.
(4) Drag of the dead airscrew added, assumed feathered to angle of least drag.
(5) Increase of drag because of offsetting rudders and ailerons to compensate for yaw and bank.
(6) Increase of induced drag because of distortion of the lift distribution curve along the span.

The results are plotted in Fig. 6. The service ceiling on three engines and the top and cruising speeds remain reasonably high. When 60 lb. per square foot loading is reached flight with one engine dead becomes difficult, although still possible if the throttles of the remaining engines are opened. On the other hand, a jettisoning system allows the weight to be reduced and flight continued at some loading about 50 lb. per square foot, after which the conditions improve rapidly.

Should one of the outer engines fail during the take-off, the conditions are very different. Much more power is in hand by the use of 100 octane fuel, but there is increased drag caused by the undercarriage and flaps being down. Further, there may not be time to feather the dead airscrew. Any adverse gust or even sub-standard atmospheric conditions reduces the rate of climb to a negligible quantity, creating a dangerous position. It would seem that taking-off at wing loadings greater than 30–40 lb. per square foot is not desirable, whether normal or assisted by catapults, inclined runways, and so forth. The safe method appears to be to keep the loading within bounds until a reasonable height is reached, and then add fuel.

Stability.—The criteria of both longitudinal and lateral stability are not affected by refuelling in flight, provided that the following precautions are taken :—(*a*) The air speed at which the refuelling is carried out must not be too low. If the machine is never flown at less than the speed of maximum climb when the overload is on board, all questions of stability in gliding flight are removed. (*b*) The moments of inertia about both longitudinal and transverse axes must be kept reasonably small. This condition is observed if the added fuel is stowed as near the centre of gravity as possible. Whilst there is a big problem in such stowage on a small aeroplane, it does not arise in large aircraft, for the centre and leading edge portions of the wing provide more than sufficient space for the load.

The remaining criteria of stability are functions of the external aerodynamic shape of the aircraft and are not affected by internal arrangements.

It is pointed out by Flight Refuelling, Ltd., that the problem is by no means so simple if certain other methods of assisting the take-off of heavily loaded machines are used. By such methods the aeroplane must on occasion be overloaded near the ground, and when flying at slow speeds, but never if refuelling is used.

Effects on Payload and Range.—In the investigation made generous allowances were given for increased structure weight, equipment, and tankage. It was assumed that the machine was to have a range of 3750 miles against a 40 m.p.h. head wind, plus a reserve of 300 miles against a 40 m.p.h. head wind. This range is equivalent to a "still air" range of 4700–4900 miles, depending upon the wing loading and consequent cruising speed.

The engines are assumed to be delivering 800 cruising B.H.P. each at 5000ft. and the fuel consumption on 87 octane fuel is 0·48 pint per B.H.P. hour. No allowance was made for the climb to height and glide-in on reaching the end of the trip, the fuel being calculated on the flat distance at 5000ft. height.

Two basic wing loadings, namely, 35 lb. and 45 lb. per square foot, were chosen. The first is immediately attainable and the second is on the limit of the I.C.A.N. requirements for take-off, the landing speed being thought to be too high for pilots to handle at present.

In each case the payload is calculated with and without the assistance of refuelling. It appears that in the normal case at 35 lb. per square foot, unassisted by refuelling, the payload is nil and the range at the stated power is less than 2000 miles. This range could be increased by throttling down, but the same would apply equally to the subsequent cases. When assisted by refuelling the required range is attained and a payload of 7000 lb. can be carried.

In the case of unassisted flight at a take-off

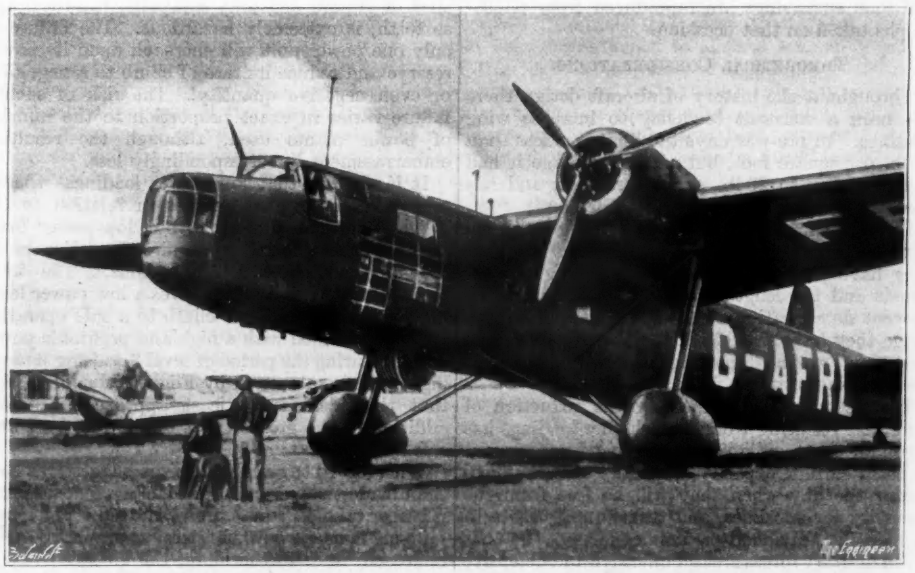


FIG. 8—"HARROW" TANKING MACHINE

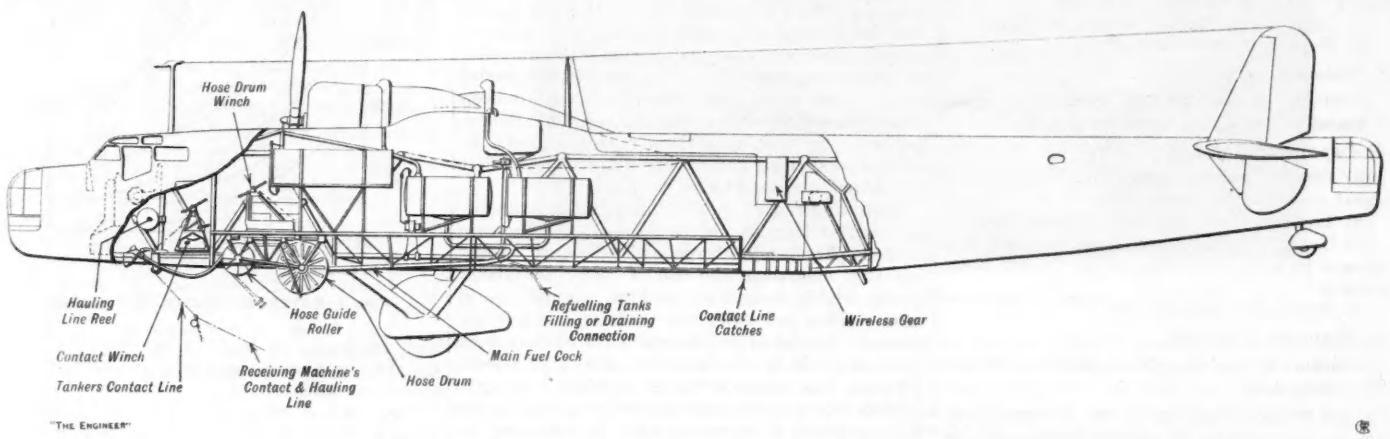


FIG. 7—GENERAL ARRANGEMENT OF "HARROW" TANKING MACHINE

loading of 45 lb. per square foot the full range is not attained, but when assisted by refuelling, not only is the full range given, but the payload is 14,000 lb.

The payloads of 7000 lb. and 14,000 lb. at 35 lb. and 45 lb. per square foot, respectively, may, of course, be used in many different ways. If a freight and mail load of 1500 lb. is taken, the remainder may be used for twenty-two passengers in the first case and fifty passengers in the second case, a personal luggage allowance of 80 lb. per passenger being made.

These figures show a marked improvement on anything yet achieved in commercial air transport. By using fuel of 100 octane value throughout, increasing the compression ratio and thus reducing the consumption to, say, 0·45 pint per B.H.P. hour (0·42 lb. per B.H.P. hour), a further considerable improvement is possible.

Similarly, Flight Refuelling, Ltd., claim that for military aircraft a corresponding increase in range and load can be made, and the offensive power of a striking force doubled in one stroke. Furthermore, this improvement is one which can always be added on top of other improvements, whether they be in boundary layer control, oil engines, or alcohol blends.

METHODS OF JETTISONING FUEL

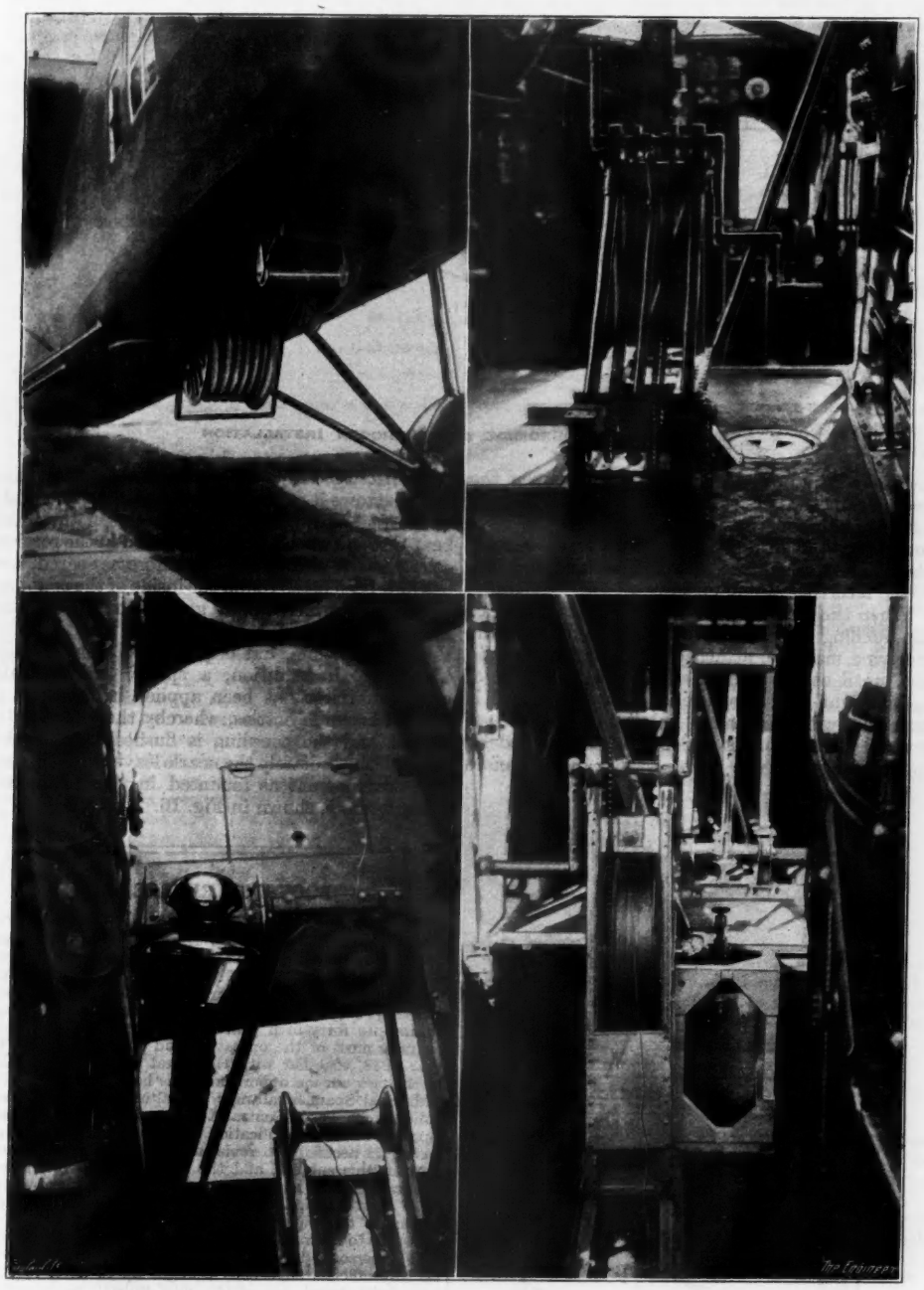
Jettisoning has in the past been carried out with varying success, depending on the degree of care taken in the lay-out of the system. It is not sufficient to put a "dump" valve in the bottom of a petrol tank, and to let the petrol gush out through a near opening in the fuselage or wing surface. But when proper care has been taken the process has been successful.

Danger arises mainly from the risk of fire and gassing of the crew. A typical cause of fire danger is where the petrol tank is situated in the wing, close to the engine. If the exhaust pipes lead out on the upper surface and the petrol is discharged on the lower surface, the relative pressures of the upper and lower regions are sufficient to cause a danger of vapour being drawn into the neighbourhood of the exhausts.

The danger arising from gassing of the crew is similar in its action. Petrol discharged anywhere near the fuselage may, in vapour form, be sucked into openings and follow the natural flow of air from rear to front of the cabin, leaving the machine at the low-pressure region above the pilot's cockpit. In an aeroplane designed for high altitude flying and fitted with a pressure cabin this danger should be much less.

There are two types of jettisoning which may be necessary, namely, rapid and slow jettisoning. Rapid jettisoning is necessary in the case of an engine failure when taking off with an overload, and must be carried out within a few seconds. Rapid discharge will always introduce a hazard because of the possibility of electrification by splashing. It need never be necessary with the refuellable machine, since it is not overloaded near the ground.

Slow jettisoning may be required on a refuelled machine, since time is available to discharge petrol before coming down to a dangerously low height. One method suggested is to have a large diameter canvas pipe folded up under the machine. This pipe must be sufficiently long to carry the petrol away into stable air outside the region affected by the passage of the machine. It would be bonded by earthing the exit rim or nozzle to the earth system of the aeroplane. The pipe would be unrolled by springs and by the pressure of petrol inside when the valve was opened. Tests are being carried out by Flight Refuelling, Ltd., to perfect the details.



FIGS. 9, 10, 11 AND 12—HOSE, WINCHES AND NOZZLE ON TANKING MACHINE

REFUELLING EQUIPMENT

As already mentioned, the equipment available at present for experimental purposes and for establishing the Atlantic air mail service is embodied in four "Harrow" type R.A.F. bombing machines, and an A.W.23 machine. The last-named aircraft is equipped both for receiving and tanking, for experimental purposes, and is shown during the Hamble trials in Fig. 2, used as a tanker in conjunction with one of the "Empire" flying boats.

Dealing firstly with the equipment on the tanking machine, a general arrangement drawing of the "Harrow" tankers is reproduced in Fig. 7, in which the positions of the winches and hose pipe gear are indicated. In these machines the capacity of the fuselage fuel tanks is 125 gallons each, the wing tanks 142 gallons each, and the total amount of fuel available for transfer is 960 gallons. For its own engines 150 gallons is provided in a fuselage tank. The crew consists of one pilot and two operators, giving an all-up weight of 25,218 lb. and empty weight of 15,946 lb. The arrangement can also be seen in the half-tone engraving, Fig. 8. Projecting under the fuselage is the hose reel, shown in Fig. 9, through the axis of which petrol flows from the pipe to be seen leading away to the transfer fuel tanks. An ingenious design of seal, which is claimed to be leakproof, is applied at the junction of the fuel pipe and the spindle of the hose reel. The winding gear for the hose, which is manually operated and is equipped with a brake, is illustrated in Fig. 10. It is situated behind the pilot's seat and a good view of all operations is ensured by windows in the fuselage side. As shown in the general arrangement view and the photograph reproduced in Fig. 11, the end of the hose terminating in a special nozzle is brought forward under the machine and through an opening in the bottom of the fuselage, where it is temporarily secured by a quick-acting clamp.

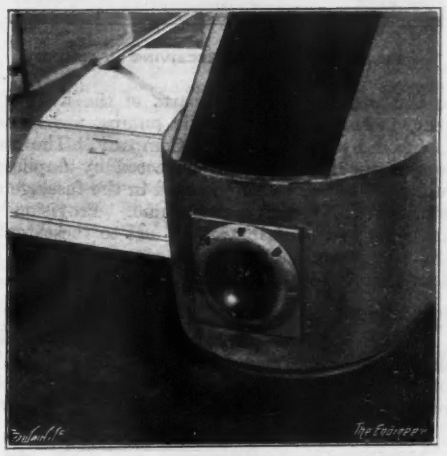


FIG. 13—HOSE ORIFICE ON RECEIVING MACHINE

Several ways of contacting the line trailing behind the receiving machine have been devised. A simple method consists of flying the tanking machine a little below, to one side and behind the receiving machine, and overtaking it until the trailing line, with its weight attached, strikes the leading edge of the tanking machine's wing, well away from the airscrew. When this operation is complete the pilot turns away from the receiving machine's line of flight and the cable slides along the wing until at the tip it engages with a hook which is spring-loaded. From this hook, which is detached by the outward pull of the cable, a second cable is connected *via* a grapnel situated under the fuselage and to the rear of the wings, to a second winding winch, illustrated in Fig. 12. The purpose of the grapnel is to ensure that the cables and weight shall not foul the undercarriage or other parts of the tanking machine. It is a simple matter with the above arrangement, it will be seen, to haul in the two cables which are now interconnected.

The equipment on the receiving machine is simple and should not weigh more than about 100 lb. The engravings Figs. 13, 14, 15 show this equipment as fitted on the A.W.23 machine, but on the "Empire" flying boat it is very similar and is somewhat after the fashion of the sketch reproduced in Fig. 16. In the tail of the machine

is a shroud into which the hose nozzle can be drawn by a cable wound on the winch. This cable is provided with a heavy weight at its end an is contacted, as described above, by the tanking machine. Within the shroud the nozzle fits on to the coupling, shown in Fig. 17. Jaws, acting under hydraulic pressure, close over the nozzle and make a petrol-tight joint. The operation of the coupling is quite automatic and is arranged so that the pressure on the jaws can be adjusted to give any predetermined break-away pressure. The coupling is arranged in the form of a breeches pipe, and the petrol flows through the two legs of the breeches, the hauling cable passing through the centre line

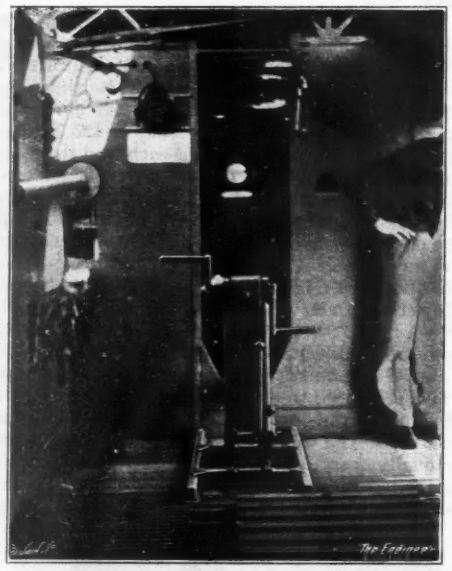


FIG. 14—WINCH ON RECEIVING MACHINE

to the windlass. Certain parts of the hydraulic gear, including the hydraulic pumps, are manufactured by the Lockheed Company. The two legs of the breeches are connected by duplicate fuel pipes to the tanks arranged in the fuselage or wings of the receiving machine. Provision is made for even distribution of fuel to these tanks and for prevention of overflowing, by means of float-operated cut-off cocks.

PRECAUTIONS AGAINST ELECTROSTATIC EFFECTS

Various precautions have been taken in the design of the equipment to guard against all risks of fire resulting from electrostatic effects. In refuelling in flight, such causes may be present,

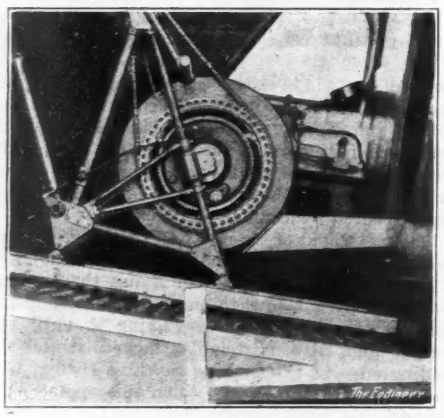


FIG. 15—WINCH ON RECEIVING MACHINE

and should petrol vapour in explosive proportions also be present, a conflagration might result.

Three components exist for dangerous conditions, namely, sufficient electrical discharge, petrol vapour and oxygen. If all three exist together, there is danger, but by suppressing any one of them the danger is eliminated.

An aeroplane picks up electrical charges by surface friction and by impact of small charged particles; by passing through varying conditions it is always electrically unstable, picking up and discharging continually, usually gently, but sometimes violently. In addition, friction between the fuel and the inner surface of the hose may give rise to static electricity, and so may splashing in tanks. Fires have been caused by the inefficient earthing of tanks and pipe lines, by the use of chamois leather filters instead of metal meshes, and by the shooting of jets of petrol into tanks from a filler cap at the top.

The following precautions have been taken :—

(1) *Difference in Potential Between the Two Machines.*—The first and most obvious case of voltage gradient is that which may exist between the receiving aircraft and the tanker as they approach one another.

The first contact between the two aircraft is made when a flexible steel wire rope—the hauling line—is lowered from the receiving aircraft and connection made with the tanker. This metallic contact is made in the complete absence of petrol vapour, and at a distance of 100–200ft. from the receiver. From that moment until the completion of the whole operation the two aircraft are bonded metallically together, and there can, of course, be no appreciable variation in voltage between the two machines. The hose pipe is spirally armoured with a continuous steel wire, which is tested as a conductor. It is earthed to the tanker aircraft above and through the metal nozzle and coupling to the receiving aircraft below.

When the machines are separating at the end of the fuelling operation, the hauling line on the receiving machine, attached to the nozzle, is paid out, until at the end of the reel some 100ft. of special light cord is reached. This cord, which is provided with a weak "link" in the form of severed strands, parts under the load applied by the tanking machine flying away, and therefore

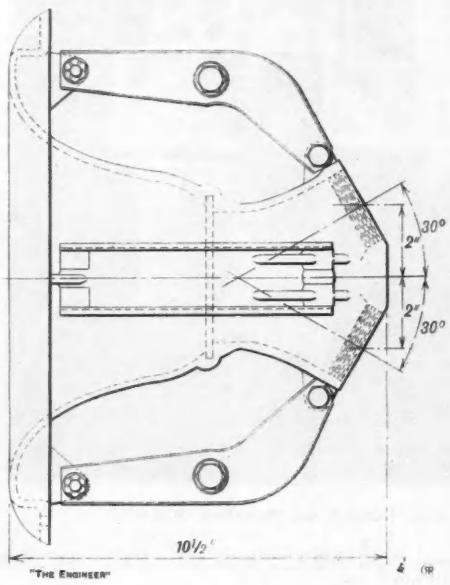


FIG. 17—HOSE COUPLING

the disconnection between the two machines is made at a safe distance from either aircraft.

We are informed that throughout the flying tests and contacts made by Flight Refuelling, Ltd., over a period of three years, under all weather conditions, there has never been the slightest evidence of a spark passing between the two aircraft. No spark has been seen, nor has any damage ever been found which could have been caused by an electrical discharge.

(2) *Frictional Electricity in the Pipe Lines.*—There can be no danger of fire caused by the passage of petrol through the metal pipe lines in either aircraft, since any charge is immediately dissipated, for the pipe lines are bonded to the metal structure of each aircraft. Attention can therefore be concentrated on conditions inside the rubber hose pipe and on the moment when the advancing fuel splashes down the pipe and into the receiving tanks.

No steep voltage gradient can exist, but as a precaution provision has been made for ensuring that oxygen is not present at critical times. Bottles of compressed nitrogen are provided in the tanking machines, as can be seen in Fig. 12, so that the hose pipe and the receiving tanks can be completely filled and flushed with nitrogen before and after the fuelling operation.

(3) *Electrification by Splash in Tanks.*—The fuel is fed, in the "Empire" boats of the "Cabot" class, into the bottom of the tank through an earthed tube. Furthermore, the inert nitrogen travelling down the pipe lines ahead of the fuel dilutes the oxygen in the tank and makes the danger even more remote.

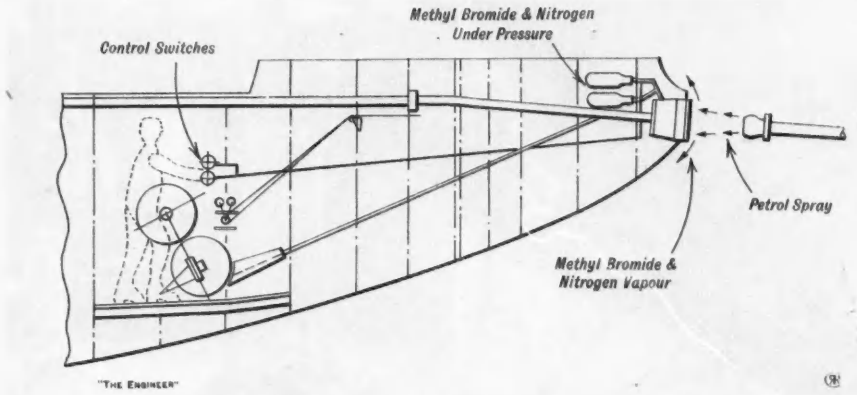


FIG. 16—METHYL BROMIDE AND NITROGEN INSTALLATION

(4) *Receiver and Nozzle Coupling.*—During trials at Felixstowe it was thought that a small quantity of the fuel had entered the rear end of the flying boat through the claw slots provided in the receiver coupling. A shroud was therefore prepared, and has now been fitted round the inside of the coupling. Any petrol which might gush into the coupling at the moment of breaking away may still run through the slots, but is prevented from entering the hull. In addition, a special automatically acting inhibitor has been applied in the form of methyl bromide bottles, whereby the inside of the shroud and the coupling is flushed with methyl bromide immediately the nozzle leaves the coupling. The arrangement as mounted in the "Empire" flying boats is shown in Fig. 16.

BOOKS OF REFERENCE

The Universal Directory of Railway Officials and Railway Year Book, 1939–40. London: The Directory Publishing Company, Ltd., 33, Tothill Street, Westminster, S.W.1. Price 20s. net.—"The Universal Directory of Railway Officials," originally issued in 1895, reaches with the present volume its forty-fifth year of publication. The volume includes most of the operating and other figures for the year 1938, together with the latest annual information. In the new edition opportunity has been taken to include additional Spanish railways and alterations arising from political changes in Central Europe. The increasing development in the electrification of main line steam railways has again necessitated revision of the tabulated information on this subject, and the table of the world's total railway mileage has been amended from official replies to a questionnaire. It contains three indexes, namely, an index to countries, a general index, including all reference to railways and statistical and other information, and a personal index of railway officials. The lists of railway officials have been brought up to date, together with brief description of the chief railway governmental and other authorities exercising control over railways.

Oil and Petroleum Year Book, 1939. London: Walter E. Skinner, 15, Dowgate Hill, E.C.4. Price 10s. net.—The new edition of this book gives complete and up-to-date particulars concerning 850 companies engaged in producing, transporting, and marketing oil, financing oil development, or directly associated in any way with the oil industry in all parts of the world. Lists are given of the officials connected with the companies, and the particulars of each company include the directors and other officials, date established, location of property or description of business, oil production, capacity of refineries, capital, dividends, and financial position.

F.B.I. Register of British Manufacturers, 1939–40. London: The Federation of British Industries, 21, Tothill Street, S.W.1.—We are informed that eight thousand copies of this reference book are issued free annually to overseas buyers of British goods. It covers a wide range of products, which are divided into more than five thousand classified headings, varying from aircraft to jewellery and shipbuilding to textiles. In addition to classified lists of products with the manufacturers' names and addresses, the volume contains useful lists of trade associations, and brands, and trade marks.

Lloyd's Register Statistical Tables

LLOYD'S REGISTER BOOK for 1939–40 has now been issued to subscribers by the Committee of Lloyd's Register of Shipping. The new edition contains, as usual, very complete particulars of all sea-going merchant vessels of the world of 100 tons and upwards, and also of steel and iron vessels trading on the Great Lakes of North America, and of other vessels classed with the Society. It includes a detailed record of more than 31,000 steamers, motorships, sailing vessels, and non-propelled craft.

The section of the book which is probably of most general interest to our readers is that containing the statistical tables. These tables, which were first published in 1886, give extensive and precise information respecting the various merchant fleets of the world, and form a very valuable series of statistical data.

The following is a summary of an analysis of the tables, and comparison with similar tables issued by Lloyd's Register in previous years, and is of considerable interest.

World Tonnage in Existence at June, 1939, and June, 1938

Where owned.	1939. Steamers and motorships.	1939. Sail and non-propelling.	1939. Total.	1938. Steamers and motorships.	1938. Sail and non-propelling.	1938. Total.
Great Britain and Ireland	17,891,134	93,024	17,984,158	17,675,404	105,455	17,780,859
Other countries	50,618,298	837,203	51,455,501	49,194,747	870,905	50,065,652
Total	68,509,432	930,227	69,439,659	66,870,151	976,360	67,846,511

CLASSIFICATION OF VESSELS

The number and tonnage* of existing vessels recorded in the new edition of the Register Book which are now or have formerly been classed by the Society or for which classification or reclassification is contemplated, is 14,328 of 42,565,346 tons. Practically all these vessels have been built under the inspection of the Surveyors of Lloyd's Register. Of the tonnage actually holding the Society's class, 48·4 per cent. is registered under the British flag (43·4 per cent. in Great Britain and Ireland, and 5·0 per cent. in British Dominions, Colonies, &c.), and 51·6 per cent. in other countries.

The tables show that during the last twelve months there has been a decrease in the steam tonnage owned in the world of 46,453 tons, an increase of 1,685,734 tons in the motor tonnage, and a decrease in the tonnage of sailing vessels and non-propelled craft of 46,133 tons, making a net increase of 1,593,148 tons in the total tonnage for the world. Between June, 1937, and June, 1938, there was a net increase of 1,560,487 tons.

The countries showing notable increases for the last twelve months are:—Japan, 623,133 tons; Germany, 248,873 tons; Norway, 220,897 tons; Great Britain and Ireland, 203,299 tons; Italy, 157,969 tons; Holland, 117,489 tons; Panama, 106,318 tons; and British Dominions, &c., 64,142 tons. Owing to the difficulty experienced in obtaining precise information in the case of Soviet Russia, the figures given for that country may not be comprehensive. The largest decreases are the following, viz.:—China, 214,654 tons; Greece, 108,603 tons; and Spain, 45,032 tons.

COMPARISON OF STEAM AND MOTOR TONNAGE

In the table given below the number and gross tonnage of steamers and motorships owned in the world as recorded in Lloyd's Register Book for the years 1914 and 1939 are given:—

Countries.	1914. No.	1914. Gross tons.	1939. No.	1939. Gross tons.	Difference between 1939 and 1914. No.	Gross tons.	Tonnage per cent.
Great Britain and Ireland	8,587	18,892,089	6,722	17,891,134	−1,865	− 1,000,955	− 5·3
British Dominions	1,536	1,631,617	2,255	3,110,791	+ 719	+ 1,479,174	+ 90·7
British Empire, total	10,123	20,523,706	8,977	21,001,925	−1,146	+ 478,219	+ 2·3
Denmark	576	770,430	705	1,174,944	+ 129	+ 404,514	+ 52·5
France	1,025	1,922,286	1,231	2,933,933	+ 206	+ 1,011,647	+ 52·6
Germany	2,090	5,134,720	2,459	4,482,662	+ 369	− 652,058	− 12·7
Greece	407	820,861	607	1,780,666	+ 200	+ 959,805	+116·9
Holland	709	1,471,710	1,523	2,969,578	+ 814	+ 1,497,868	+101·8
Italy	637	1,430,475	1,227	3,424,804	+ 590	+ 1,994,329	+139·4
Japan	1,103	1,708,386	2,337	5,629,845	+1,234	+ 3,921,459	+229·5
Norway	1,656	1,957,353	1,987	4,833,813	+ 331	+ 2,876,460	+147·0
Spain	589	883,926	777	902,251	+ 188	+ 18,325	+ 2·1
Sweden	1,088	1,015,364	1,231	1,577,120	+ 143	+ 561,756	+ 55·3
United States: Sea	1,113	2,026,908	2,345	8,909,892	+1,232	+ 6,882,984	+339·6
Lakes	579	2,260,441	508	2,451,641	− 71	+ 191,200	+ 8·5
Other countries	2,749	3,477,311	3,849	6,436,358	+1,100	+ 2,959,047	+ 85·1
World total	24,444	45,403,877	29,763	68,509,432	+5,319	+23,105,555	+ 50·9

The preceding table shows that from June, 1914, to June, 1939, the net increase in the world's steam and motor tonnage was 23,105,555 tons, equal to 50·9 per cent. of such tonnage in existence in 1914, and that the net addition in the number of vessels was 5319.

Since June, 1914, there has been a net decrease in the steam and motor tonnage belonging to Great Britain and Ireland of 1,000,955 tons, or 5·3 per cent. of the tonnage owned in 1914, while the number of ships has decreased by 1865 during the same period. In the British Dominions, Colonies, &c., there has been an increase of 1,479,174 tons (90·7 per cent.) and 719 vessels since 1914; so that the totals for the British Empire at June, 1939, compared with those at June, 1914, show an increase of 478,219 tons (2·3 per cent.), but a decrease of 1146 vessels. The aggregate increase of tonnage owned in other countries during the same period represents more than 90 per cent. of the pre-war tonnage owned.

Further comparison of the figures of other countries for 1914 and 1939 shows that the largest increases took place in the United States (sea), 6,882,984 tons; Japan, 3,921,459 tons; Norway, 2,876,460 tons; Italy, 1,994,329 tons; Holland, 1,497,868 tons; France, 1,011,647 tons; and Greece, 959,805 tons. The only decrease during this period, other than in Great Britain and Ireland, was that in the case of Germany, where, although the number of vessels has increased by 369, the present total tonnage is still 652,058 tons below that at June, 1914.

The present century has witnessed unprecedented development in the mercantile fleets of the world, the steam and motor tonnage having increased from 24,009,000 tons in 1901 to 68,509,000 tons in 1939. In the case of Great Britain and Ireland the figures have risen from 12,053,000 tons to 17,891,000 tons, and the concurrent increase in the tonnage owned abroad is indicated in the following table, comprising the eight leading countries:—

Country.	Percentage of steam and motor tonnage owned in the world. 1901.	1914.	1939.
Great Britain and Ireland	55·2	41·6	26·1
United States (sea)	4·2	4·5	13·0
Japan	2·2	3·8	8·2
Norway	3·4	4·3	7·1
Germany	10·1	11·3	6·5
Italy	2·7	3·1	5·0
France	4·4	4·2	4·3
Holland	2·1	3·2	4·3

Of these leading countries it will be seen that, apart from Great Britain and Ireland, France was the only one to show a decrease in the proportion of tonnage owned during the period 1901–14, and that since 1914 Great Britain and Ireland and Germany alone show a decrease.

TONNAGE OF SAILING VESSELS, NON-PROPELLED BARGES, &c.

The reduction in the tonnage of sailing vessels and non-propelled barges, &c., since pre-war times is from about 3,963,000 tons gross at June, 1914, to 930,000 tons gross at June, 1939. The present proportion of such tonnage to the world's total tonnage is only 1·3 per cent. Of the world's tonnage of such sailing vessels and barges, 513,000 tons (55·1 per cent. of the total) are now under the United States flag, and the other countries which still have an appreciable amount of similar tonnage are:—Great Britain and Ireland, 93,000 tons; Canada, 81,000 tons; Finland, 35,000 tons; Italy, 24,000 tons; Argentina, 22,000 tons; and France, 19,000 tons.

If barges, the majority of which are generally towed, and other craft included in the sailing tonnage because not fitted with engines for self-propulsion, be excluded, the world tonnage of sailing vessels amounts only to some 226,000 tons, of which 56,000 tons (24·7 per cent. of the total) belong to the United States, 35,000 tons are owned in Finland, and 23,000 tons in Italy. It may be of interest to state that there are still recorded in the Register Book five sailing vessels of between 3000 and 3200 tons gross each.

SIZE AND AGE OF STEAMERS AND MOTORSHIPS

A considerable increase has taken place in recent years in the number of sea-going steamers and motorships of 4000 tons and above. In 1914 there were 3608 such vessels, and now the number reaches 6589, of which 576 are of 10,000 tons and above, including 82 of 20,000 tons each and upwards. Of the 576 vessels, 258 are under the British flag.

It may be noted that over one-half of the total number of steamers and motorships recorded in Lloyd's Register Book are of less than 1000 tons each. One of the tables shows that of the motorships now in existence in the world there are 1848 of 4000 tons and above; 453 of them are between 8000 and 10,000 tons each, and 233 are of 10,000 tons and upwards.

From another table, in which steamers and motorships are classified according to their size and age, it will be noticed that there are 3658 vessels less than five years old, with a tonnage representing 15·5 per cent. of the total steam and motor tonnage. Vessels of twenty-five years and over amount to 9944, with an average tonnage of 1420 tons, compared with 2903 tons for those under five years of age. Of the 1452 vessels of 8000 tons and upwards now in existence, 403 have been built during the last five years.

Of the tonnage owned in Great Britain and Ireland, 21·1 per cent. is less than five years old. Of the principal maritime countries abroad, those having the largest proportion of new tonnage (less than five years old) are Japan with 27·5 per cent., Australia and New Zealand together with 25·7 per cent., Norway with 24·6 per cent., Holland with 22·5 per cent., Germany with 19·9 per cent., Denmark with 16·7 per cent., Sweden with 15·0 per cent., and France with 13·2 per cent.; on the other hand, of the United States sea-going tonnage only 6·0 per cent. and of Greek tonnage 5·8 per cent. is under five years old, while Spain has but 2·1 per cent., and Canada and Italy each 1·7 per cent. Of the tonnage registered in Great Britain and Ireland 76·9 per cent. is under twenty years old and 55·9 per cent. is under fifteen years old; while the corresponding percentages for the tonnage owned abroad are 58·3 and 35·9 per cent. The size group of vessel with the largest aggregate of tonnage is that from 4000 to 6000 tons comprising 18,084,659 tons, equal to 26·4 per cent. of the world's total steam and motor tonnage. Vessels of 15,000 tons each and upwards represent only 5·9 per cent. of the total tonnage. It may be noted, however, that upwards of 45 per cent. of such tonnage is registered in Great Britain and Ireland.

TYPE OF MACHINERY

One table gives particulars of the number and gross tonnage of steamers and motorships according to the type of machinery used for their propulsion, and the following summary is of interest:—The figures show the extent of the great development which has taken place in the use of steam turbine engines and of internal combustion engines. There are now 1964 steamers of 12,617,958 tons fitted with turbine engines or a combination of steam turbines and reciprocating engines, and 7551 vessels, including auxiliary vessels, of 16,918,687 tons, fitted with internal combustion engines, as compared with 730,000 tons and 234,000 tons respectively in 1914. While during the last twelve months there has been an increase of 1,686,000 tons in the tonnage of motorships, and of 288,000 tons in the tonnage of vessels fitted solely with steam turbines, there has been a reduction of 521,000 tons in steamers fitted only with reciprocating steam engines. Since June, 1925, there has been an increase of 14,205,000 tons in the motorship tonnage. It will be observed that of 11,436,880 tons of oil tankers, excluding vessels of less than 1000 tons gross, 5,421,337 tons are steamers and 6,015,543 tons are vessels fitted with internal combustion engines.

Although the total motor tonnage amounts only to 24·4 per cent. of the aggregate tonnage owned in the world, and, in the case of Great Britain and Ireland, to 25·6 per cent. of the tonnage registered there, the highest percentages among the principal maritime countries are to be found in the following, viz.:—Norway, 62·2; Denmark, 52·2; Sweden, 46·6; and Holland, 45·4; whereas Greece, the United States, Canada, and France have the smallest proportions of motor tonnage, viz., 1·1, 6·7, 11·2, and 14·8 per cent. respectively.

An analysis of the type of machinery now employed also shows that there are recorded in Lloyd's Register Book 671 vessels, with a total tonnage of 2,890,376 tons which are fitted with a combination of steam turbines and reciprocating engines. Another interesting particular is that in the case of 118 vessels, with a tonnage of 685,510 tons, electric propulsion has been adopted, the motors being supplied with current from generators which are driven either by

* The figures regarding tonnage of vessels throughout these notes refer to gross tonnage.

steam turbines or oil engines. It may be added that auxiliary electric drive has also been adopted in a number of other cases. Of the 118 vessels mentioned above, 61 of 278,031 tons are owned in the United States. Of vessels exceeding 20,000 tons gross in which electric propulsion is employed, five fly the British Flag, four are owned in the United States, and one each in France and Germany.

Of the 29,763 steamers and motorships of 100 tons gross and upwards recorded in Lloyd's Register Book, 3858 are twin-screw vessels, and 100 have triple or quadruple screws. Although few paddle steamers are now built, there are still in existence and recorded in Lloyd's Register Book 268 such vessels, of 186,590 tons.

Coal and Oil Fuel

Another table shows that there are recorded in the new Register Book 4202 steamers of 20,575,676 tons fitted for burning oil fuel, of which 849 of 5,298,778 tons are registered in Great Britain and Ireland, and 1421 of 7,525,769 tons are registered in the United States of America. These figures, in conjunction with those given in the preceding section, enable a comparison to be made between the respective employment of coal and oil fuel at the present time and in 1914. Figures are also given which show clearly the trend in the employment of fuel during the last five years :—

Fuel.	Percentage of total gross tonnage.					
	1914.	1935.	1936.	1937.	1938.	1939.
Coal	88·84	50·15	49·10	47·89	46·54	44·67
Oil fuel for boilers	2·65	30·65	30·38	29·84	29·57	29·63
Oil, &c., in internal combustion engines	0·45	17·42	18·89	20·74	22·45	24·36
Sailing vessels, non-prop. barges, &c.	8·06	1·78	1·63	1·53	1·44	1·34
	100·00	100·00	100·00	100·00	100·00	100·00

It will be noted that well under 50 per cent. of the tonnage of the world's merchant marine now depends entirely upon coal, while in 1914 the percentage was nearly 89. The tonnage of steamers using coal which in 1914 reached 43,860,000 tons is now 31,015,000 tons, or nearly 13 million tons less. It should, of course, be understood that oil is not necessarily always used in steamers fitted for burning oil fuel, as in a number of cases coal-burning fittings can readily be substituted when occasion demands the use of coal in preference to oil.

Types of Vessels

The tables show the total tonnage of certain types of vessels, and this information is of great service in enabling an estimate to be made of the tonnage available for general cargo and passenger purposes. The tonnage of the 1731 oil tankers, of 1000 tons gross and upwards, amounts to 11,436,880 tons ; 435 of 2,919,566 tons are registered in Great Britain and Ireland, 421 of 2,800,780 tons are registered in the United States, and 272 of 2,117,381 tons in Norway. In addition, there are 148,669 tons of tankers of less than 1000 tons each. The tonnage of steam and motor trawlers and other fishing vessels and whalers amounts to 1,185,116 tons. An analysis of the vessels recorded in the Register Book shows that 434,429 tons represent tugs and salvage vessels ; ferries amount to 250,827 tons ; cable vessels to 66,023 tons, while river vessels and vessels owned by municipal corporations or harbour authorities, and steam barges, dredgers, and similar craft, amount to 527,599 tons. It will thus be seen that, without taking into account size, age, or material, there are about 14,050,000 tons of vessels which are not used for ordinary cargo and passenger purposes.

Ocean-going Steamers and Motorships for General Cargo and Passenger Purposes

If all vessels of the types mentioned in the preceding paragraph be omitted, and disregarding also :

(*a*) Vessels trading on the Great Lakes of North America ;

(*b*) Wooden and composite vessels ;

(*c*) Vessels of less than 4000 tons gross, and

(*d*) Vessels of twenty-five years of age and upwards, presumably of less efficiency than more modern vessels (with the exception of a few, built earlier than 1914, which are still capable of a high speed),

the figures given in the table in the adjoining columns are obtained which indicate the relative position of the principal maritime countries as regards the more efficient ocean-going vessels available for general cargo and passenger purposes.

The table shows the relatively high efficiency of the merchant fleet of Great Britain and Ireland, which, while including 26·11 per cent. of the world steam and motor tonnage as recorded in the Register Book, actually comprises 35·29 per cent. of the more efficient ocean-going tonnage available for general cargo and passenger purposes.

Further comparison of the ocean-going tonnage, as defined above, with the total steam and motor tonnage owned, shows the following differences in percentage of the world totals, viz.:—Germany, +1·67 per cent.; Japan, +1·21 per cent.; Holland, +1·15 per cent.; Italy, +0·77 per cent.; France, +0·45 per cent.; Norway, −2·82 per cent., and the United States, −1·81 per cent. The reductions noted for the two latter countries are, of course, due to the very large proportion of oil tanker tonnage included in their respective merchant fleets, and also in the case of the United States, to the considerable tonnage trading on the Great Lakes, such tonnage being deducted for the purposes of the second part of this table.

Countries.	Total steamers and motorships owned (as per table No. I).			Ocean-going steamers and motorships (as defined above).		
	No.	Gross tons.	Percentage of world tonnage.	No.	Gross tons.	Percentage of world tonnage.
Great Britain and Ireland	6,722	17,891,134	26·11	1,503	10,739,378	35·29
United States of America	2,958	11,490,177	16·77	706	4,551,619	14·96
Japan	2,337	5,629,845	8·22	455	2,868,079	9·43
Germany...	2,459	4,482,662	6·54	323	2,497,202	8·21
Italy	1,227	3,424,804	5·00	233	1,756,764	5·77
Holland	1,523	2,969,578	4·33	215	1,668,787	5·48
France	1,231	2,933,933	4·28	186	1,439,954	4·73
Norway	1,987	4,833,813	7·06	241	1,290,042	4·24
Other countries	9,319	14,853,486	21·69	621	3,618,685	11·89
World totals	29,763	68,509,432	100·00	4,483	30,430,510	100·00

Tonnage Owned in the World

Another table clearly illustrates the development of the merchant navies during the last thirty-five years, and shows for each of the years 1905–1939 the number and the gross tonnage of the steamers and motorships, and of the sailing vessels, owned in the world, distinguishing also the principal maritime countries.

From this table some remarkable variations can be observed. In 1905 the gross tonnage of steamers amounted to 29,963,000 tons, and the gross tonnage of sailing vessels to about 6,464,000 tons. Since then, the steam and motor tonnage has increased by more than 38½ million tons, while the sailing tonnage has decreased by more than 5½ million tons. Apart from the enormous increase which took place in the United states sea-going steam and motor tonnage from 1916 to 1922, and the decrease during the period 1914–20 in the German tonnage, both due to the war, the following are the most noticeable changes during the thirty-five years :—The sail tonnage registered in Great Britain and Ireland and in Norway, which in 1905 amounted to about 1,411,000 tons gross and 750,000 tons gross respectively, is now reduced to about 93,000 tons (mostly non-propelled barges, &c.) and 1100 tons respectively. The increase in the steam and motor tonnage owned in Great Britain and Ireland amounted to 3,394,000 tons. As compared with 1905 the most notable increases in steam and motor tonnage owned are shown at the present time by the following countries, viz.:—The United States (sea), with a tonnage now equal to 6·7 times the earlier figures ; Japan, 6·5 times ; Greece, 5·1 times ; Italy, 4·6 times ; Norway, 4·5 times ; and Holland, 4·5 times.

Tonnage Lost and Broken Up.

The statistical tables include one showing the tonnage of steamers and motorships lost and broken up in each calendar year from 1915 onwards. As regards losses, one point deserves special mention, and that is the considerable decrease in the percentage lost during the last five years as compared with the pre-war quinquennial period. The average yearly percentage of steam and motor tonnage lost during the years 1934–38 amounts only to 0·56 per cent., whereas during the years 1909–13, for instance, the average was 1·17 per cent. Apart from the improvement in means of communication and safety appliances generally, these figures may, of course, be influenced to some extent by the large amount of tonnage laid up at times during recent years.

The figures for steamers and motorships broken up vary to a very large extent from year to year. During the period 1905–14 the minimum was 87,737 tons and the maximum 251,900 tons. During the years 1915–20 practically no tonnage was broken up, the yearly average only amounting to 10,000 tons. Quite different conditions are shown for recent years. During 1921 the tonnage broken up amounted to 77,500 tons ; it increased to 315,000 tons for 1922, and to 963,000 tons for 1923, since which year it has kept at a high level with the exception of the year 1927. From 1930 the figure rose sharply until 1933, when the two million mark was passed. During the next four years the totals rapidly decreased, and the 587,823 tons broken up during 1937 and the 580,923 tons during 1938 are, with the exception of 1927, the lowest annual figures recorded since 1922. The total for 1938 is 430,000 tons less than the yearly average for the last five years, and 582,000 tons less than that for the ten-year period 1929–38.

The aggregate steam and motor tonnage broken up during these ten years, 11,624,000 tons, represents a yearly average of 1·8 per cent. of the tonnage owned. Adding to these figures the tonnage of steamers and motorships lost through casualties during the same period, 3,651,000 tons, it will be seen that the average wastage of sea-going merchant tonnage, excluding sailing vessels, is less than 2·4 per cent. per year of the tonnage owned.

The total figures for tonnage broken up during the ten years include 3,791,000 tons registered in Great Britain and Ireland ; 2,115,000 tons in the United States, excluding Lake vessels, 1,087,000 tons in Italy, 867,000 tons in France, 595,000 tons in Germany, and 563,000 tons in Japan.

As regards Great Britain and Ireland, the tonnage broken up during this period represents a yearly average of 2·0 per cent. of the tonnage owned, as compared with 1·7 per cent. in respect of tonnage owned abroad. It is to be noted further that of the tonnage now owned in Great Britain and Ireland only 23·1 per cent. consists of vessels of twenty years of age and above, whereas of the tonnage owned abroad, 41·7 per cent. consists of vessels of such age.

Sixty Years Ago

In our issue of August 1st, 1879, we recorded the death at the age of fifty-three of Monsieur Louis Favre, the contractor for the St. Gothard Tunnel. He died, we said, like a general on the field of battle, with the sound of victory ringing in his ears. Shortly before his death he had issued invitations to his friends to meet him in the near future midway in the workings to celebrate the completion of the tunnel. But it was not to be ; he died of apoplexy inside the gallery. Favre was born of obscure parentage in the canton of Geneva in 1826. His education was indifferent, and he began life as a workman. His ability and energy, however, soon carried him upwards and, rising from the ranks, he became a builder and contractor on his own account. Finding Geneva too narrow a field for his activities, he removed to Paris, and acquired much money and a high reputation as an undertaker of public works. When the contract for the construction of the St. Gothard Tunnel was put up for public competition, his tender was accepted, and such was the confidence felt in him that he had no difficulty in persuading the bankers of his native city to provide the sum of £250,000 required by the Federal Council as security for the due execution of the contract. He based his calculations on the substitution of dynamite for gunpowder in the driving of the tunnel, and on the use of compressed air drills, recently invented by his fellow-townsman, Professor Colladon. There was a heavy penalty against failure to complete the contract by the specified date, and also a premium for completion before such date. All Favre's calculations were justified, and had not the financial arrangements of the St. Gothard Tunnel Company completely broken down, the work would have been finished in well under the nine years specified in the contract. We recorded that at one time he had to defray all the current expenses from his own resources. Indeed, had not Favre been strenuous and persevering and the Genevese bankers generous and confiding, the tunnel would have been abandoned at an early stage. His fertility of resource and his immense energy carried him through, but the labour and anxiety attending the task were believed materially to have shortened his life. Had he lived, he would probably have been awarded the contract for the Simplon Tunnel, for a month before his death he was in Paris negotiating with the French Government concerning its construction.

Camouflage.—Camouflage was a word that came to most people with the Great War. It meant the employment of a new system for disguising ships and guns, camps, troops on the move, and so on. But though it may have been new to soldiers and sailors, the principle was already familiar to scouts and woodmen. As far back as 1905 Mr. Reginald Ryves, Assoc. M. Inst. C.E., contributed to *The Field* an article on "The Optics of Skulking and Scouting," in which, not only were the principles of camouflage laid down, but actual suggestions for the treatment of ships, guns, men, &c., were detailed. Some years ago the author reprinted the article, together with some personal war experiences, in camouflage as a little pamphlet, and in view of A.R.P. he is now making it available to those interested in the subject. Copies —4d. each post free—can be obtained from him at 37, Priory Avenue, Harlow, Essex.

Rail and Road

MOTOR VEHICLES IN GREAT BRITAIN.—More than 2,000,000 private motor cars had licences current on May 31st last, and the total number of mechanically propelled vehicles of all kinds exceeded 3,100,000.

THE PROPOSED SEINE ROAD BRIDGE.—A public inquiry has been opened into the utility of the proposed high-level road bridge over the River Seine between Tancarville and Port Jerome. Plans for the bridge have been put forward by the port of Havre and are being opposed by the port of Rouen. The construction of such a bridge would reduce the distance between Havre and Southern Normandy by about 50 miles.

NEWCASTLE AND NORTH SHIELDS COAST ROAD.—Preliminary surveys have been completed for the construction of a new road adjoining the Newcastle and North Shields coast road. The present road, which carries traffic in both directions, will become a one-way traffic lane and, with the new road adjoining it, will have a total width of 100ft. The scheme is estimated to cost £250,000, and is expected to take two years to complete.

IRON ROADS.—For some years an iron surfaced highway, laid down for experimental purposes at the University of Minnesota, has been giving satisfactory results. The experiment is now to be enlarged by the laying down of a 2000ft. length of iron surface on a State road near Eveleth, Minn. A considerable amount of iron ore is produced in this State, and the large-scale adoption of the type of road surface would be of considerable benefit to its industry.

PROPOSED GOVERNMENT LOAN TO AMERICAN RAILWAYS.—A Bill introduced into the United States Senate provides, amongst other things, for the purchase by the Reconstruction Finance Corporation and lease to the companies with or without the option to buy, 500 million dollars' worth of new railway equipment. The Bill also proposes the setting up of a 750 million dollar loan for the construction of "self-liquidating" toll roads, bridges, high-speed highways, and city by-passes.

AN L.N.E. RAILWAY BUFFET CAR SERVICE.—Two buffet restaurant cars have been built by the London and North-Eastern Railway Company specially for its through service from Aberdeen and Penzance to the South of England. The cars combine the amenities of a restaurant car with those of a buffet car. Each vehicle has two saloons, one being arranged for dining purposes and having accommodation for twelve passengers, whilst the other portion of the car is arranged as a buffet. A large combined kitchen and pantry is provided for service to both saloons.

THE BRITISH MOTOR INDUSTRY.—The annual statistics of the British motor industry for 1938 have just been issued by the Society of Motor Manufacturers and Traders. As compared with 1937, there was a decrease in production of private cars and taxis of 12·1 per cent., and in commercial vehicles of 11 per cent., the total number of vehicles produced being 447,561, a decrease of 60,188. It is shown that in September last there were over 1,984,400 private and 656,770 commercial vehicles in use in this country. During the year under review over 1467 million gallons of spirit and nearly 102 million gallons of oil were consumed in motor transport work.

ITALIAN RAILWAY ELECTRIFICATION.—According to recent statistics compiled by the Italian Ministry of Communications, 43 per cent. of the total train miles in that country are now being covered by electric trains. Of the remaining train mileage, 40 per cent. are steam trains and 17 per cent. railcars, and motor coaches with oil or petrol engines. During the present year the international line from Ventimiglia and Modane to Rome is to be opened for electric traction. Electrification of the railways in 1938 is estimated to have permitted a saving of over 1¼ million tons of coal. When the new line is opened to electric trains it is estimated that a further saving of 388,000 tons of coal per year will be made.

INDIAN ROLLING STOCK CONSTRUCTION PROGRAMME.—The Finance Committee of the Indian Railway Board has approved the expenditure of about Rs. 3,90,25,000 on the purchase of rolling stock during 1940–41. Of this amount some Rs. 1,60,75,000 has been allocated for locomotives and boilers, and Rs. 96,00,000 for carriage stock. It has been decided that the construction of broad-gauge engines in one of the existing workshops may prove remunerative, and the programme allocates Rs. 77,25,000 for the purchase of 1550 broad-gauge general service wagons and about Rs. 12,75,000 for 128 broad-gauge oil tank wagons. Provision has been made to purchase thirty-seven additional engines at a cost of Rs. 64,00,000 for the increased traffic on the East Indian Railway.

ENGINES FOR MANCHESTER AND LONDON EXPRESSES.—In order to provide greater efficiency and economy by hauling heavier loads with a single engine at the high speeds required, the London, Midland and Scottish Railway Company has transferred to its Longsight (Manchester) depôt two locomotives of the "Princess Royal" type, the largest and most powerful on the system. These locomotives will be used to work the "Mancunian," "Lancastrian," and "Comet" 3½-hour services, on which they will be able to haul 500 tons unaided, compared with 415 tons which is the maximum that the "Royal Scot" engines can take without assistance on the fastest Manchester to London duties. The two engines transferred to Longsight are the "Princess Elizabeth" and the "Princess Beatrice."

A NEW BUFFER ON THE UNDERGROUND.—A series of tests was recently carried out by the engineers of the London Passenger Transport Board on a new type of buffer for use in the Underground Railway tunnels. The buffer is of the hydraulic type, and has been designed for use in the limited space available in the tunnels. Its hydraulic cylinder and ram are situated below the rail level and bracketed to the buffer above. It was tested in a short trap siding branching off the eastbound approach tunnels to Aldgate East Station. A six-car train of old Metropolitan stock, weighing 180 tons, was first run into the buffer with 30 foot-tons of impact energy, and then at varying speeds until 1000 foot-tons of impact energy was reached. We have been given to understand that the tests were entirely satisfactory.

Miscellanea

COAL MINES IN U.S.S.R.—There are reported to be thirty new coal mines in course of construction in the Tula province of the U.S.S.R. Their aggregate annual output is estimated at over eight million tons.

CEYLON ELECTRICITY SCHEME.—The Ceylon State Council has passed a vote of over £1,000,000 for a national hydro-electric scheme. The vote covers four contracts, three of which will be placed in Britain and one in India.

MOTOR VEHICLE FUEL.—It is reported that a mixture of liquefied butane and propane has been successfully used as a fuel for motor vehicles in the U.S.S.R. Reports state that the fuel has been found to possess higher anti-knock properties than ordinary petrol, and engines are more easily started in cold weather.

LEEDS ARMS FACTORY.—Sir Victor Warrender, Financial Secretary to the War Office, in a written reply to a question in the House of Commons, states that it is proposed to establish a new Royal Ordnance factory near Leeds for the manufacture of guns, and that negotiations for the purchase of a site of approximately 30 acres are in hand.

STEEL HELMETS.—Seven hundred thousand steel helmets are waiting in Government stores for issue to members of air raid precautions squads in industrial and commercial establishments. But few orders are being placed for them. Arrangements have been made by the Government, through a joint committee of employers representing all sections of industry, for the supply of helmets, and order forms have been made available for the purpose. Firms who are not members of any trade association can obtain them by applying directly to the Finance Office, Home Office, Whitehall, London, S.W.1. The helmets cost 8s. 6d. each, and seven sizes, corresponding with the ordinary hat sizes, are available.

THE COAL UTILISATION COUNCIL.—A new constitution has been adopted for the Coal Utilisation Council, which in future will be known as the Coal Utilisation Joint Council. Originally set up by the Mining Association of Great Britain in conjunction with the coal distributors, manufacturers and suppliers of coal-burning appliances will now have representation on the Council. The Council will consist of not less than fifty-eight members, of whom thirty will be appointed by the Mining Association, twelve by the Chamber of Coal Traders, eight by the Combustion Appliance Makers' Association (Solid Fuel), two by the British Coal Exporters' Federation, one by the Co-operative Wholesale Society, one by the Co-operative Coal Trade Association, and four by the ironmongers' and builders' merchants' associations.

A.R.P. IN INDUSTRY.—A pamphlet, "A.R.P. in Industry," explaining the Civil Defence Act, has been prepared by the Lord Privy Seal's Department for the guidance of owners and occupiers of industrial and commercial establishments. It is a revised and amplified description of the Act, replacing the pamphlet bearing the same title which was issued at the time this measure was introduced into Parliament. The Act lays important obligations on owners and occupiers of commercial establishments in vulnerable areas specified in the Act where more than fifty people are employed, and creates other obligations with regard to such establishments where more than thirty people are employed in any part of the country. Copies of the pamphlet may be obtained, free of charge, on application to the Publicity Section, A.R.P. Department, Horseferry House, Thorney Street, S.W.1.

IRON AND STEEL INSTITUTE AUTUMN MEETING.—The autumn meeting of the Iron and Steel Institute will be held in Cardiff from September 12th to 15th by the invitation of the Iron and Steel Industries of South Wales. The meeting will be officially opened by the Lord Mayor of Cardiff at 7 p.m. on Tuesday, September 12th, at the South Wales Institute of Engineers. This meeting will be followed by a technical session for the presentation and discussion of papers. On the Wednesday visits have been arranged to the East Moor Works of Guest, Keen, Baldwins Iron and Steel Company, Ltd., and the works of Guest, Keen and Nettlefolds, Ltd. The day will conclude with a civic reception at the City Hall. The whole of Thursday will be taken up with a visit to the Ebbw Vale Works of Richard Thomas and Co., Ltd., and the day will be concluded with a dinner at the City Hall by invitation of Guest, Keen, Baldwins Iron and Steel Company, Ltd. Excursions on Friday morning to Newport will cover visits to the works of John Lysaght, Ltd., Newport and South Wales Tube Company, Ltd., or the Whitehead Iron and Steel Company, Ltd. These visits will be followed by a luncheon at Newport and a garden party at Cardiff Castle in the afternoon.

INSTITUTE OF METALS AUTUMN MEETING.—The Council of the Institute of Metals has issued the programme of the thirty-first annual autumn meeting to be held in Glasgow from September 5th to 8th, 1939. Members will be received at the conference headquarters in Glasgow—the Institution of Engineers and Shipbuilders—in the evening of Tuesday, September 5th, by the Lord Provost of Glasgow, the Chairman of Governors of the Royal Technical College, and the President of the Glasgow Chamber of Commerce. After a short business meeting, Mr. W. Murray Morrison will deliver the seventeenth autumn lecture on "Aluminium and Highland Water Power." In the morning of Wednesday the first technical session will be held under the chairmanship of Dr. C. H. Desch, and seven papers will be presented for discussion. After the meeting members will lunch by invitation of the Scottish Local Section, and then visit the works of John Brown and Co., Ltd., Henry Wiggin and Co., Ltd., and Albion Motors, Ltd. In the evening there will be a civic reception at the City Chambers. The concluding scientific session, held on Thursday morning, will be devoted to a general discussion on "Machinability," based on a series of papers appearing in the August issue of the Institute's *Monthly Journal*. Following this meeting there will be an official luncheon at the Beresford Hotel. Afterwards members will visit the works of Glenfield and Kennedy, Ltd., and Barr and Stroud, Ltd. On the concluding day of the meeting—Friday, September 8th—there will be an all-day excursion on the River Clyde.

Air and Water

BUSK STUDENTSHIP IN AERONAUTICS.—The trustees of the Busk Studentship have awarded the studentship for the year 1939–40 to Mr. R. H. Whitby, City and Guilds College, London.

NEW ADMIRAL OF THE FLEET.—Following the retirement of Admiral Sir Reginald Tyrwhitt, it is announced that Admiral Sir Dudley Pound has been appointed Admiral of the Fleet.

THE "DUNLUCE CASTLE" TO BE SCRAPPED.—The 8131-ton passenger and cargo vessel "Dunluce Castle," of the Union-Castle Line, has been sold for breaking up. This vessel was built in 1904 by Harland and Wolff, Ltd.

TRIALS OF THE "PASTEUR."—The new French 28,500-ton liner "Pasteur," built for the South American service of the Compagnie de Navigation Sud Atlantique, has run her first sea trials. She will begin her maiden voyage on September 14th next.

WIRELESS BEACON AT LONGSTONE.—The Marconi Company has received an order from Trinity House to install automatic marine wireless beacons for the safeguarding of navigation at Longstone Lighthouse in the Farne Islands, and on the Outer Gabbard Light Vessel.

SHIPBUILDING IN THE UNITED STATES.—According to a report of the American Bureau of Shipping, 129 ships, aggregating over 631,800 gross tons, are at present under construction in shipyards in the United States. The 24,800-ton liner "America" is the largest of the seagoing vessels being built and she will be launched next September.

NEW BRITISH NORTH ATLANTIC AIR MAIL SERVICE.—The Postmaster-General announces that, following the introduction, on Saturday August 5th, of a weekly British air service on the route Southampton, Botwood, Montreal and New York, there will be two direct air mail services each week to North Amreica, one by British and the other by United States aircraft.

HIGH-SPEED GERMAN BOMBER.—What is claimed to be a record has been set up by a German all-metal Junkers bombing machine fitted with two 1000 H.P. engines. The machine flew 2000 kiloms. at an average speed of 501 kiloms. per hour. It is also stated that two other international records were broken—over 2000 kiloms. with a load of 1 ton and without load.

NEW FRENCH CRUISERS.—Contracts have been placed by the French Government for the construction of two 8000-ton cruisers similar to the "De Grasse," now being built at Lorient. These ships will have a speed of 32 knots and their main armament will be three turrets each of three 5·7in. guns. The two new vessels will be named "Chateaurenault" and "Guichen."

BRITISH AIRCRAFT INDUSTRY SCHOLARSHIPS.—Six scholarships in the aircraft industry have been awarded for 1939 in the third year of the scheme financed by the Society of British Aircraft Constructors, and administered by the Royal Aeronautical Society. The joint committee representing the two societies interviewed ten youths selected from several hundred applicants.

AVIATION IN TURKEY.—The Turkish Government has announced its intention of inaugurating a new air service between Angora and Smyrna and Angora and Diyarbekir, and between Angora and Van and Erzerum during 1940. For these extensions the Government are about to purchase a number of new machines with a greater passenger and luggage capacity than those which it already possesses.

EMPIRE FLYING BOATS.—Whilst alighting at Alexandria on Sunday, July 30th, the Imperial Airways flying boat "Camilla" damaged a port float. On the same day the "Awarua" set up a record flight for commercial aircraft by completing a 3469 miles journey in thirty-nine hours, of which twenty-three hours were flying time. In addition to thirteen passengers, the machine carried a large quantity of mail and freight.

CANADIAN OIL RESOURCES.—The tar sands of McMurray, in the northern section of the Canadian province of Alberta, are estimated to hold sufficient heavy oil to supply the British Empire for 100 years. Researches are being made to eliminate completely the sand from this oil, which, if mixed with the fine oil produced in the Turner Valley, in the southern section of the province, would result in an oil suitable for the requirements of the British Navy.

LAID-UP SHIPPING.—The Chamber of Shipping's quarterly returns of ships laid up at the ports of Great Britain and Ireland show that 123 ships of 281,866 tons net, or 477,086 tons gross, were idle on July 1st last. This is a reduction of 135,864 tons net, or 32·5 per cent., compared with the previous quarter, and of 50,138 tons net, or 15·1 per cent., compared with a year ago. The decrease in British tonnage laid up compared with three months ago amounted to 67,065 tons net, or 123,135 tons gross.

A LARGE FLOATING PILEDRIVER.—Special floating pile-driving equipment has been constructed to drive steel H-beam piles up to 175ft. long in 80ft. of water for the new Potomac River bridge at Ludlow Ferry in the United States. It was stipulated that the piles should be driven by a steam hammer having a ram weighing not less than 14,000 lb., delivering 37,500 foot-pounds per blow. As built, the complete hammer weighs 16 tons and it has a 7-ton ram, striking at the rate of sixty blows a minute. The floating rig consists of a 90ft. A-frame tower, the fixed leads of which carry inner extensible leads, that can be raised 60ft. above the top of the tower or lowered 95ft. below deck level.

G.W.R. APPOINTMENTS AT SOUTH WALES DOCKS.—The Great Western Railway Company announces that the following appointments will take place at the South Wales Docks on August 28th next:—Mr. L. E. Ford, dock manager at Cardiff and Penarth, to be principal assistant to the chief docks manager, Mr. W. J. Thomas; Mr. H. B. Smith, dock manager at Newport, to be dock manager at Cardiff and Penarth; Mr. T. J. Edmunds, dock manager at Port Talbot, to be dock manager at Newport; Mr. T. Carpenter, assistant dock manager at Barry, to be dock manager at Port Talbot; Mr. W. Jeffers, outdoor assistant coal, shipping and traffic section, Cardiff Docks, to be assistant dock manager at Barry.

EQUIPMENT AT THE FACTORY OF MACLEANS, LTD., BRENTFORD, MIDDLESEX

(For description see page 120)

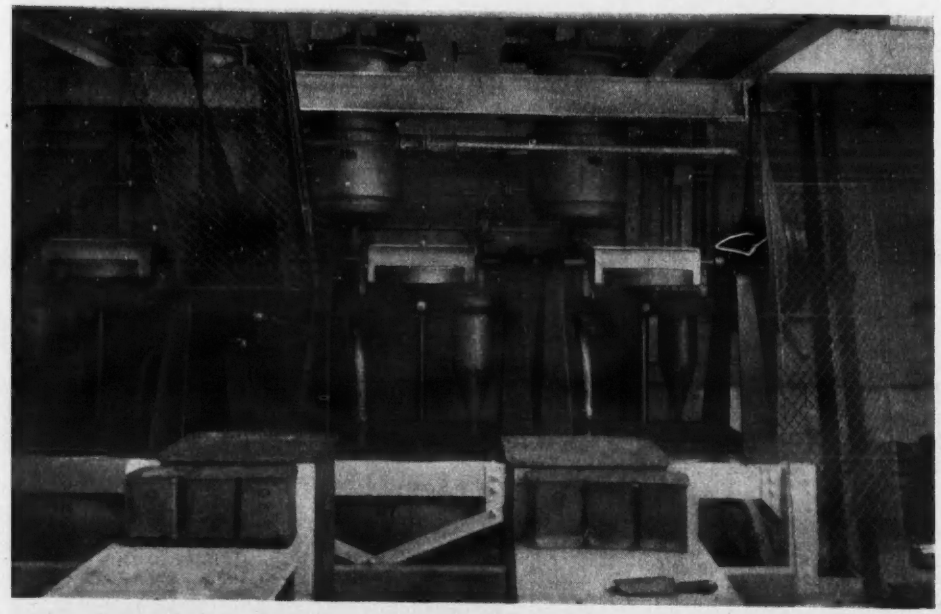


FIG. 4—TOOTHPASTE FEED DRUMS AND STIRRING PANS

FIG. 6—CONVEYORS FOR PACKING CARTONS

FIG. 5—FILLING COLLAPSIBLE TUBES

FIG. 7—STOMACH POWDER DEPARTMENT

The Engineer

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CHANGES OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

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PACIFIC LOCOMOTIVES

THERE is no steam locomotive type more popular the world over for the haulage of express passenger trains than the "Pacific." It has proved itself in service through many years of experience in all countries, and has rarely been found wanting. Its bogie, properly designed and maintained, gives good control on the straight and on curves, its small carrying wheels at the back obviate rear overhang, whilst permitting the use of as wide a fire-box as the gauge allows, and its six coupled wheels provide adequate adhesion without excessive axle loads for trains of considerable weight. Moreover, whilst the rigid wheel base is short, a long boiler can be used without any difficulty. Every locomotive type is perforce a compromise. There are always some controlling conditions which restrain the designer from doing exactly what he would like to do, but, taken for all in all, the "Pacific" wheel arrangement covers so many of the essential points that it may be regarded as one of the happiest of compromises for passenger services ever devised. But, as the small boy said in an essay, "the horse is a noble animal, but does not always do so." And so it may be said of "Pacifics." We know of one class on a first-rate line in this country which leaves much to be desired, and every engineer knows now that certain standard "Pacifics" on Indian railways have given so much trouble that speed restriction has had to be imposed. These troubles led to the appointment of the very expert committee under the chairmanship of Lieut.-Colonel A. H. L. Mount, whose report has occupied so much of our space in recent weeks. But whilst the findings of that Committee condemn certain features of the Indian engines, they do not, and this ought to be made quite clear, arraign "Pacifics" as a type.

In our two issues of July 21st and 28th we reprinted, practically in full, Chapter III of the Indian report. We hesitate to say how many times we have read that chapter, but do not hesitate to say that, however many more times we may read it, particularly in conjunction with Chapter VII, of which we begin the reprinting to-day, we shall still find something in it to think about. It is, to our mind, the best essay of a purely practical kind on the locomotive as a vehicle that has ever been written. A great deal of theorising about railway engines has been indulged in, but it has had to be based on certain assumptions, and a locomotive running on a track—for they twain are one—simply refuses to be pegged down to assumptions to oblige the mathematician. No other engine in the world works under such astounding conditions. The alignment of cylinder and crankshaft is being continually changed as the axle-boxes rise and tilt in the horns, the stresses on the journals and crank pins not only vary as the adhesion varies, but may alter from side to side, whilst the whole engine may be swung laterally by its own influences or a defect in the road, or it may pitch up and down, settle down at the front or rear, or shuttle backwards or forwards parallel to the track. There are, as defined by the Committee, no less than eight separate and distinct motions to which the locomotive as a vehicle is subject, and to most of them, possibly all of them, singly or in combination, the steam engine proper has to accommodate itself. Small wonder, then, if mathematicians have found the resolution of all the forces beyond their limitations, and that "generally speaking, in the many different engine designs all over the world, designers have arrived at an arrangement *based on engineering instinct and experience*, which has been quite satisfactory in practice." The italics are ours. In its investigations, the Committee adopted this practical line of action. Broadly speaking, one may say that its purpose was to find out why some locomotives caused distortion of the track. An ideal engine running on the straight would exert no lateral forces on the rails; it would never cause distortion. The problem therefore before the Committee was to find out why certain "Pacifics" at speeds over 45 m.p.h. or so did exert flange pressure. In this work it could get little or no help from theory. "To the best of our knowledge," it says, "the actual mechanical process by which track distortion occurs is not yet exactly known. Mathematical theory has been used to work out equations of motion, but these have been so complicated as to be insoluble. Moreover, to make calculation possible, it has been necessary to make numerous assumptions, in order to allow of the possibility of integration and final solution. But these assumptions, however carefully they are based, have had the effect of altering the interpretation of the problem, and therefore the results obtained have not, up to the present, been of great assistance." That is why the practical research which is being done, and which is detailed in Chapter VII, is of such importance, and why so much is to be hoped from the Locomotive Research Station which is arising in this country. Thus, with little or no theoretical knowledge to help them, the members of the Committee, all thoroughly practical people, with not a professor amongst them, had to rely on experience, intuition, and observation, and they had to arrive at their conclusions by arguing from certain facts that had been established by actual tests—see Chapter VII—or that accorded with experience. Many of their points are uncommonly interesting, and a few are intriguing. Amongst the latter we may place the resistance to sideways movements, owing to what one may call the lateral adhesion of the wheel on the rail. There is a familiar law that if friction be overcome in one direction it will also be overcome in all other directions. Hence, if there is any slipping of the wheels in a forward direction, the resistance to lateral movement must be reduced. As slip is always going on owing to the coning of the tyres, and as it is continuously varying, so this lateral adhesion must be a very variable quantity, and the part it plays in preventing nosing may be a very doubtful and variable quality. Amongst the interesting facts determined by recent experiments, we note that, even in guided locomotives, it is generally the coupled wheels which bring about the highest sideways reactions on the rails. The art of making an engine run without nosing lies in decreasing—as can be done to a considerable degree—this reaction of the driving wheels "by increasing to a small extent the flange pressure on each of the two bogie wheels." Another very illuminating comment is that elastic deformations of the track quite sufficient to provoke serious disturbances in the engine, are sometimes "not readily visible after the passage of the engine." In other words, inspection of the track cannot always be relied upon alone to disclose the cause of engine disturbances. We have not space to touch upon all the considerations such as these which finally led the Committee to the conclusion that the side control of the bogie, having regard to the characteristics of the hind truck, is really the crucial matter. If the bogie relieves the pressure of the driving wheel flanges on the rails, then there will be no further difficulty with these Indian "Pacifics."

There are so many more instructive points in this chapter that we put it down with reluctance. Some of them, like that covered in the paragraph entitled "Couple Due to Piston Thrust," raise questions that have long been debated, and we may perhaps return to them. For the moment our purpose will be served if we have tempted any, even though they be not locomotive engineers, who may have overlooked the chapters of the report that we are reprinting to give them their attention.

A New Type of Foreman

IN many respects the most difficult post in the industrial world is that of foreman, in that he is the intermediary between the management and the rank and file; while he does not enjoy those privileges normally accorded to the upper staff, he is expected to be loyal to the superior powers, in spite of the fact that his previous experience—indeed, his whole life—has tended to bias all his sympathy in favour of the manual worker. In days gone by foremen were invariably promoted craftsmen, frequently selected, not so much because they had a better knowledge of the work and of methods of production, as because the management believed they were able to extract the maximum effort from the men entrusted to their care. They were little dictators in their own sphere, exercising arbitrary control, sometimes despotic, sometimes paternal, according to their individual temperaments, while the fact that they could take on and discharge men at will placed a very potent weapon in the hands of the unscrupulous. Furthermore, the system paved the way to favouritism and its inherent vices.

As far back as thirty years or more ago some enlightened engineers realised that a change was desirable, and appointed "gentlemen foremen"—opprobrious title, as if they failed to realise that many of the old type of foremen were "Nature's gentlemen," even though others might be "Nature's bullies." The educated man in a number of cases earned the respect of the worker to a greater degree than his predecessor of the old school, and made good in a post that was then regarded as an anomalous one. While progressive employers were experimenting with different types of men for staff appointments, the whole system of organisation and administration was undergoing extensive modification, and from the simple "military" method a transition was taking place, through the "line and staff" to the "functional," which increasingly finds favour in the engineering world. At the same time, the introduction of piecework, bonus, and other

incentives to output, limited the value of the driver foreman. Concurrently with these changes the standard of general education advanced. Thus by degrees, and in some respects imperceptibly, the field was prepared for a new class of foreman. No longer can the foreman engage his own men; this has become the function of the labour department. The foreman is now a member of a team, and if he is to prove a success he must have the gift of co-operation in a marked degree. Whatever may be said for or against the educational systems in vogue in our universities and technical colleges, the daily life in them, with their social and other activities, all tend to develop a team spirit and to widen the general perspective. This fact has contributed greatly towards making the well trained man a success as a foreman. But if he is to gain and hold the respect of the working man, not only must he acquire a reputation for scrupulous fairness, but he must be able to enter into the life of the mechanic, understand his outlook, and at the same time show positively that he has a thorough knowledge of the work and of workshop conditions. It is suggested that for this purpose a full apprenticeship is most desirable, and one with no special privileges other than educational, afforded to the apprentice. He will make many valuable contacts and appreciate the other fellow's outlook, and if he is wise he will take into his confidence some of the best of the operatives. He will endeavour to couple personality with efficiency. A case might be cited of a college-trained man who has proved an outstanding success as a foreman of a big forge, as unlikely a sphere as might be conceived. He has attained a greatly increased output from the big forging presses in his shop, he has increased the life of the various tools, and at the same time has introduced into his surroundings an air of efficiency and cleanliness rarely met with in a smithy. Being liked and respected by his men, he was able to inculcate the team spirit in a truly remarkable way. What one man can accomplish others can also, given similar conditions. There is, however, one definite problem that has to be faced: at the present time the well-educated foreman is still in the minority, so that when he has proved himself it is relatively easy to promote him, but assuming that all foremen were of the new type where would be found the avenue of promotion? The old type was content to remain a foreman to the end of his days; the new type would be disgruntled, and perhaps for that very reason eventually become a subversive influence in the shop that he once ruled efficiently. But problems arise to be solved, and most big organisations will be able to work out their own salvation by a scheme of upward mobility, with opportunities for transfer from one functional department to another.

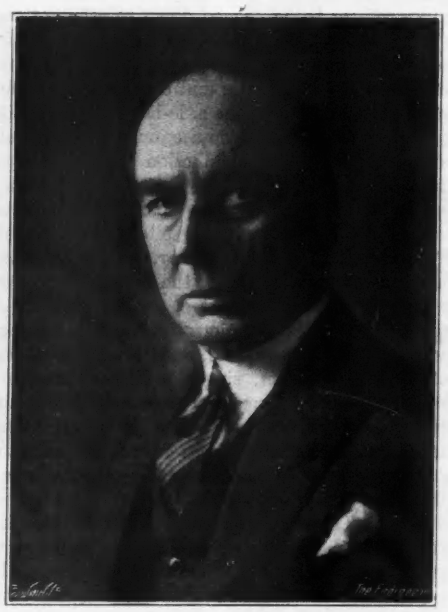
Let it not be imagined that there is any suggestion of class distinction in this change of type of foreman, a change which has occurred to meet the new conditions of industry. The man of gentler birth, with probably a public school education, followed by a university training, finds himself in an advantageous position, which he has possibly acquired relatively easily, since it has not been necessary for him to move from his own sphere. On the other hand, the enterprising trade apprentice can compete quite effectively with his more favoured brother if he realises the limitations of his normal environment and is prepared to devote his spare time to broadening his education and fitting himself to cope with the present requirements of the modern engineering works. He can obtain a scholarship to the university, and eventually he will be none the worse for having earned his promotion by more arduous means. Industry cannot remain static; conditions are ever changing, and it is accordingly well to recognise that the new type of foreman has come to stay. Rate fixing, planning, progressing, cost accounting, and the other functions of so-called scientific management have all contributed towards the necessity for a foreman who is characterised by personality rather than brawn, who resorts to common sense rather than coercion, and above all who has a capacity for sympathetic and intelligent co-operation.

Obituary

ENGINEER VICE-ADMIRAL SIR ROBERT B. DIXON

The boiler engineering industry has lost a leading figure and the Royal Navy one of its most outstanding engineer officers of recent years by the death of Engineer Vice-Admiral Sir Robert Dixon, which took place on Friday, July 28th, at Sydney, New South Wales, following a short illness. Sir Robert was on a business journey for Babcock and Wilcox, Ltd., of which he was a director, and had only arrived in Sydney a few weeks ago. In his forty years of service in the Royal Navy, he occupied important positions afloat, and in the Royal Dockyards, while at the Admiralty he rose to be the Engineer-in-Chief of the Fleet, succeeding Sir George Goodwin in June, 1922, and retiring in 1928. On his retirement he joined the board of Babcock and Wilcox, Ltd., and also became interested in several other important engineering firms.

Robert Bland Dixon was born in 1867 at Darlington, and received his education at Queen Elizabeth's Grammar School in that town. He showed great interest in scientific and engineering



Eng. Vice-Admiral Sir Robert Dixon, K.C.B.

subjects, and at the age of fifteen years was sent for a six years' course to the Royal Naval Engineering College at Keyham. At the end of that course, which he passed with distinction, he was awarded the rank of Assistant Engineer and went on to the Royal Naval College at Greenwich, which he left in 1891, at the head of a list of brilliant contemporaries. In that year he joined his first ship, H.M.S. "Hecla." His next appointment was to the finest battleship then afloat, H.M.S. "Trafalgar." A year later he returned to London, and was posted to H.M.S. "President" to serve as Lecturer and Assistant to the late Professor James H. Cotterill, who was then Professor of Applied Mechanics at the Royal Naval College, Greenwich. He was a clear and convincing lecturer, and his work at Greenwich was greatly appreciated by the engineers and naval architects who attended his classes.

In February, 1897, he was appointed to H.M.S. "Centurion," which was then the Flagship of the China Station, but after a year he was reappointed to H.M.S. "President" to serve at the Admiralty under the late Sir John Durston. The following year he went to Chatham Dockyard in charge of the Engineer's drawing office, a position he occupied until 1902. In 1900 he became Chief Engineer, and on leaving Chatham was appointed in April, 1922, First Assistant to the Engineer at the Royal Dockyard, Portsmouth. About that time reorganisation was taking place in the Navy. The old ranks of Chief, Staff, and Fleet Engineer, and Inspectors and Chief Inspectors of Machinery, disappeared from the Navy List, and the present system was introduced, Sir John Durston becoming Engineer-in-Chief of the Fleet. Robert Dixon received the new title of Engineer Lieutenant, dated back to September, 1890, and by 1904 he had risen to the rank of Engineer Commander, having been on the books of three ships, H.M.S. "Victory," H.M.S. "Duke of Wellington," and H.M.S. "Fire Queen." As Engineer Commander he was appointed in 1904 to the Dockyard Department of the Admiralty, in which he served for three years, returning to sea in 1907 as Engineer Commander of H.M.S. "Dominion." Two years later he was made Chief Engineer of His Majesty's Dockyard at Haulbowline. About that time Lord Fisher's scheme for the training of engineer officers was being considered, and in 1912 Dixon was appointed by the Admiralty a member of the Custance Committee, which was set up in order to carry through the scheme, and to put it into operation. In October, 1912, he was made Manager of the Engineering Department at Portsmouth Dockyard, and was subsequently appointed to the Admiralty as Engineering Assistant to the Director of Dockyards. In 1916 he was promoted to the rank of Engineer Captain, and at the close of 1918 he received the honour of C.B. In May, 1919, he was transferred to the Department of the Engineer-in-Chief, and became Engineer Rear-Admiral later the same year. On the retirement in June, 1920, of the late Rear-Admiral Edouard Gaudin, of Belleville boiler fame, Rear-Admiral Dixon became Deputy Engineer-in-Chief under Vice-Admiral Sir George Goodwin, whom he was called upon to succeed in June, 1922.

From what has been said it will be appreciated that all through his career Admiral Dixon was closely associated with, and took the keenest interest in all that related to the entry, training, and status of the engineer officers of the Royal Navy. In all his varied duties he gained the affection and confidence of those with whom he came into contact in a very remarkable degree. He had an important share in adapting the regulations to fit in with the requirements of the Selbourne-Fisher scheme, and was responsible for selecting the first Engineer Officer to the Command of the Royal Naval Engineering College at Keyham, a very vital duty in connection with the changing nature of the engineering branch.

Soon after his retirement in 1928 he joined the board of Babcock and Wilcox, Ltd., and after that date was prominently identified with the recent developments of marine high-pressure steam propulsion. We recall his keen enthusiasm in connection with the design and lay-out of the boiler engineering works at Renfrew, and his close association with the developments of riveted and later of welded boiler drums. He was the chairman of two Babcock subsidiary companies, Edwin Danks and Co. (Oldbury), Ltd., of Birmingham, and the Clarkson Thimble Tube Boiler Company, Ltd. His work in connection with Babcock interests frequently took him to the Continent, and he also made business journeys to Brazil, the Argentine, and Australia.

Other directorships which he has held in recent years included those of the late Broughton Copper Company, Ltd., G. D. Peters and Co., Ltd., H. W. Kearns and Co., Ltd., and Foster Wheeler, Ltd. He took a great interest in the work of the leading scientific institutions, and was a member of the Council of the Institution of Mechanical Engineers and of the Institution of Naval Architects. He was also a member of the Smeatonian Society. In 1924 his work for the nation was recognised by the bestowal of the K.C.B. Two years later the honorary degree of Doctor of Engineering was conferred upon him by the University of Sheffield. The same year he served as President of the Junior Institution of Engineers, and in 1927 was elected Vice-President of the Institution of Naval Architects. In 1929 he was elected President of the Institution of Marine Engineers. Committees on which he served included the Fuel Research Board and the Committee on the Behaviour of Materials at High Temperatures.

Robert Dixon was of a very quiet, almost retiring disposition; he never thrust his views forwards, but was always ready with them when they were invited, and they were invariably well weighed and considered. Like many quiet men, he had much tenacity of purpose, and having a clear object before him he went on until he attained it. His experience of most branches of naval engineering was very extensive and invaluable to those who needed it. In his clubs, the Athenæum, and the Naval and Military, he was very popular, and his home during the lifetime of his wife was a familiar *rendezvous*. Her death three years ago was a severe loss to him. As a hostess she maintained an atmosphere in which "shop" could be talked without diffidence, while her tact on all occasions was of great assistance to him. Some years ago he suffered from a

very severe illness which interfered in some measure with his subsequent health, but could not repress his energy and love of work. The engineering world has lost by his death a man of many friends and great worth.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

STAGE EFFICIENCY OF STEAM TURBINES

SIR,—I hope you will permit me to draw attention through the medium of your columns, to a paper by Mr. D. M. Smith on "Stage Efficiency: Cumulative Heat and Reheat Factor of Steam Turbines."

This paper has just been published with written discussion by the Institution of Mechanical Engineers. I had not the pleasure of reading it before the final date for acceptance of contributions to the discussion, and I should like to take this opportunity of congratulating Mr. Smith on his very interesting and comprehensive paper, and also to thank him for the compliment he has paid me in referring to a previous paper of my own published in THE ENGINEER on a related subject.

During the discussion Mr. J. R. Finniecome presented an elaborate and detailed comparison of numerous methods of calculating the reheat factor which have been proposed from time to time, and he made the remark that my formula gave considerably higher values for the reheat factor than all the others which he considered.

There is, however, one fundamental difference between my method and most of the others which he examined, in that my formula is based upon a straight expansion line on the Mollier chart, whereas Mr. Smith and others assume a constant stage efficiency. The straight line infers gradually increasing stage efficiency, the rate of increase being very closely in agreement with the result of actual turbine calculations. It will be obvious that an expansion line based on a constant stage efficiency will give a smaller reheat factor than will a straight line representing the same overall internal efficiency ratio, and it is not therefore surprising that my formula gives figures higher than those obtained by other workers. During the last few years it has frequently been submitted to the acid test of comparison with a detailed step-by-step calculation on the Mollier chart, and it has never been found in error by more than the limits of draughtsmanship.

I feel that in referring to "the more accurate and reliable 'values'" obtained from another formula it was incumbent on Mr. Finniecome to point out the basic difference between the formulæ in question. In addition, my method of allowing for a finite number of stages represents, so far as I am aware, the first rational proof of the $(n-1)/n$ factor, which had previously been obtained as an empirical relationship.

H. G. YATES.

Rugby, July 29th.

A NEW CONCEPTION OF BUSINESS

SIR,—Various theories have been advanced in recent years concerning the remedies for the acknowledged unsatisfactory economic conditions which obtain in many countries, and few of the theories have been tested by experiments. It is therefore a relief to read about the courageous effort made by Mr. Frank Murphy. He is, at any rate, making an experiment to determine whether his own theory concerning the loyalty of individuals to a high ideal in business is correct.

It is true that in this country of Britain the accumulation of wealth, due in no small measure to the inventive ability, experiments, and enterprise of engineers, has rescued a very large number of the population from the poverty, ignorance, and disease prevalent a century ago. (The standard of life here to-day is, of course, enormously higher than in Asia.) It is also true that at the present time a very large number of people in this country are giving freely of their leisure to support those ideals, such as justice, honour, and truth, mentioned by Mr. Murphy. It was a welcome surprise to myself, absent from England for four years, to find such a vast amount of voluntary service being rendered for the good of the community.

It must be nearly thirty years ago when Mr. Frank Murphy patiently listened to my lectures on engineering at the East London College. He not only showed marked intellectual ability, but great energy. When I read of his bold experiment, a quotation from Emerson flashed through my mind. I think it runs: "What I heard first I heard last; what the English admire beyond all else is *pluck*." Every engineer will admire Mr. Murphy for his pluck, and his confidence that he is doing something that will in due course increase business efficiency. It is an experiment which, if it fails, will provide us with useful data; if successful, it will have profound results upon industry, not only in this country, but in many other parts of the world.

Experiments that seemed to others to be doomed to failure were brought to success by the enthusiasm and courage of such men as Watt, Parsons, and Diesel. This new conception of business has, for its sponsor, a capable engineer possessing not only imagination, but great enthusiasm and energy. It may encourage those engaged in the experiment to read that when the Cadburys outlined their bold experiment of a garden city for their workers at Bournville many business men in Birmingham told the writer that the scheme must fail.

On the contrary, its success has led many other firms to consider more carefully the welfare of their workers. Mr. Murphy is engaged upon a remarkable experiment; he probably needs no encouragement, but he certainly deserves the admiration of those who believe that the experimental method should be applied to economic problems.

C. A. MIDDLETON-SMITH.

Southsea, August 1st.

SIR,—I have read with much interest Mr. Frank Murphy's letter in your issue of the 28th inst. referring to your leading article of a fortnight previously. The difficulty of facing the day of adversity cannot lightly be turned aside by the suggestion that those who leave a firm at a time of depression necessarily have as their primary objective "a material gain." It is felt that Mr. Murphy gives indirect support to your doubts when he states that on one occasion no money was left for salaries apart from paying two of the staff who were going on holiday. Even if the others accepted the position "with a steady cheerfulness, as distinct from a heady enthusiasm," the difficulty remains as to whether they could face it week after week for an extended period. I consider you are fully justified in maintaining that it is necessary for Mr. Murphy's scheme—attractive though it undoubtedly is—to be in operation for a very long time before a fair judgment is possible. I, for one, should "like to see the New Conception of Business at work," and shall try to avail myself of the offer made in Mr Murphy's letter to you.

GEORGE W. TRIPP, F.C.G.I., M. Inst. C.E.

Bromley, July 31st.

Literature

SHORT NOTICES

The Economic Principles of Electrical Distribution. By Henry M. Sayers. London: Sir Isaac Pitman and Sons. 1938. Price 12s. 6d.—Written to meet the needs of electrical engineers in charge of electricity undertakings and those concerned with the commercial aspects of electricity supply problems, this book deals with the factors on which economical distribution depends and describes useful methods of calculating these factors and forecasting their course over a period of years. The volume may be regarded as a sequel to the one published in 1924 under the title of "Electricity Supply Costs and Charges." More detailed study was devoted in that volume to generation costs, although the importance of distribution costs was not underestimated. But more information concerning these costs is now available, and the effective utilisation of distribution capital has become a problem more capable of practical solution. Statistical information not previously available has been given in the report of the McGowan Committee. As the data there presented show, a wide spread of distribution costs per unit sold by British undertakings from 2·48d. to 0·5881d. in the six classes of undertakings grouped by the magnitude of sales, a wide spread in sales per pound of capital employed, and in other relevant data, a study of first principles seems to the author to be called for; but the book is not claimed to go beyond that. In view of the abundant literature on the construction of distributing systems the author makes no attempt to add to it. Nor does he deal with the much-discussed question of the reorganisation of distribution, but it is hoped that the ground covered will prove useful to those interested in the subject.

The A.B.C. Guide to Glass in Architecture, Building and Decoration. By G. S. Reynolds and G. P. Hughes. 1939. Stone and Cox, Ltd., Africa House, Kingsway, W.C.2. Price 5s., or 5s. 6d. post free.—The technology of the use of glass is almost unknown to engineers. Few of them have any idea of the varieties of glasses now available, of the limitations on their use, and of the technical terms common in the "glazing" industries. No doubt architects and builders are far better informed, but even they may welcome a volume which gives them so much information in a condensed form as that under review. The arrangement of the text is alphabetical, and at the end a series of illustrations showing the typical uses of glass is inserted. Some subjects are given no more than definitions, whilst longish articles are devoted to others, as, for example, polished plate glass, "Thermolux" glass and toughened glass. By the way, we notice what appears to be a little slip in the latter, unless glass has peculiar properties. Toughened glass is made by heating the sheets and suddenly cooling them, which, according to the "Guide" results in the interior layers being in a state of tension while the exterior layers are in a state of compression. But assuming that the glass contracts on cooling, the outer layers would compress the inner layers, thereby putting themselves in tension. That is what happens with metals, and we see no reason to doubt that it occurs with glass. We suggest that "exterior" and "interior" have been inadvertently transposed in the "Guide."

Thorpe's Dictionary of Applied Chemistry. Fourth edition. Vol. 3. By J. F. Thorpe, C.B.E., D.Sc., and M. A. Whiteley, O.B.E., D.Sc. London: Longmans, Green and Co. Price 63s. net.—This volume of the new edition covers Section C, Chemical Calculations, and Section D up to Diffusion. Like the earlier volumes of the new series, all the information has been brought thoroughly up to date and extended to take in recent developments. It includes some 250 major articles, most of which have been prepared by specialists in the particular subjects. Following previous practice, the matter is couched in as simple language as possible and the descriptions applying to plant and apparatus are supplemented by drawings and diagrams. This dictionary covers a wide field in such a thorough manner as to make it an invaluable addition to any technical library. In common with all others familiar with it, we look forward to the next volume, to be issued in 1940.

Transformer Engineering. By L. F. Blume, G. Gamilli, A. Boyajian, and V. M. Montsinger. London: Chapman and Hall. 1938. Price 25s.—Written with the object of facilitating the solution of the many and various technical problems which confront engineers in the specification selection, application and operation of transformers, this volume should appeal to many operating electrical engineers. All the authors are associated with the transformer department of the General Electric Company of America, and the book has therefore considerable practical experience behind it. Material to be found in college text-books and handbooks is not included. Similarly no reference is made to information embodied in manufacturers' publications. Moreover, since the volume deals with technical problems incidental to the operation of transformers, the subject of transformer design has been discussed only in so far as seemed useful in the solution of these problems. Engineers associated with the installation and operation of static transformers will find, however, that the volume meets practically all their needs.

AN AMERICAN ROAD TOUR

WITH a view to stimulating interest in up-to-date roads suitable for the steadily increasing traffic in this country, the Modern Roads Movement has invited a number of prominent members in administration, politics, and transport, to join it in a tour to the United States. The party will inspect the principal road developments in and around New York and Washington, and an opportunity will be given for visits to the World's Fair. The party, which leaves Southampton on September 20th, will include Members of both Houses of Parliament, County Councillors, County Surveyors, Chief Constables, and municipal authorities. It will be headed by Lord Eltisley, the Chairman of the Modern Roads Movement. The programme includes a number of interesting tours. On Saturday, September 30th, a 90-mile tour will be made of Long Island Express Highways, including Jones Beach, other seashore developments, and the Floyd Bennett airport, which has the most extensive lay-out of concrete runways yet built. On the next day a tour of the metropolitan roads in New Jersey and Westchester County will include the new Lincoln Highway Tunnel and the George Washington Bridge. The party will leave New York for Philadelphia by coach on October 3rd, and the route will include the Holland Tunnel, the Pulaski Skyway, and points where an existing four-lane pavement was converted into a divided highway by pushing the slabs apart. A number of inspection tours in the Washington area have been arranged, and will include a visit to the naval model testing basin at Carderock and a trip over the George Washington Memorial Highway.

Locomotive Research and Development*

No. I

Introductory Remarks.—Conditions to-day have passed beyond the stage when improvements and economies in engineering matters can be easily obtained by simple and obvious means. To initiate new lines of attack, progress demands the utilisation of science, and a continuous study of what is going on in other fields. This calls for controlled experiment, exact measurement, and logical development, matters which can conveniently be grouped under the term research in its widest meaning.

Research will not produce fruitful results if crowded in, as a secondary consideration, among the other duties of a busy executive. Its initiation and pursuit is a full-time occupation, and the establishment of the necessary organisation was referred to by the Pope and Wedgwood (Indian Railway Inquiry) Committees. We fully endorse the recommendations made by them, and draw attention to the increasing number of industrial, as well as national undertakings which are to-day making use of research to ensure continued progress in future.

The value of such an organisation to undertakings of the size of the Indian Railways would be incalculable. Through contacts made with other bodies specialising on specific subjects outside the railway sphere, contemporary thought and experience in the engineering world can be tapped, with the assurance that no development is taking place without an opportunity being given to study its application to the railways.

We would mention two outstanding examples. In Great Britain, the L.M.S.R. has already saved large sums of money in various fields, although its research department has been in operation for only a few years. Among others, one fundamental investigation has for some time been proceeding with regard to the action of a wheel on the rail. On the French railways, research has also produced apparatus for measuring flange pressures and track displacements. Their engineers have been faced with the problem, comparable to that in India, of sometimes running heavy high-speed engines on relatively light permanent way, and a technique for measurement has been developed which assures safety in operation under such conditions. What is being done in this respect in France and in other countries is described later in this chapter.

Central Standards Office.—In India, up to the present, the Central Standards Office, under the Railway Board, has carried out a great deal of work on the standardisation of details of rolling stock, permanent way, material, and bridges; this has been valuable to the State in connection with the standardisation of specifications and drawings, which have enabled railway administrations, and their purchasing agencies, to obtain articles to the best advantage both in India and elsewhere. The work which has been accomplished, for example, in standardising vacuum brake details, is noteworthy, and is only one of numerous fields of activity.

But though much commendable work has been done by the Central Standards Office, we feel that progress is hampered by an organisation inadequate to deal with the many problems which affect safety, comfort, and economy, and which require careful investigation, testing, and analysis. No undertaking of the size of the Indian railways can afford to be without a properly organised and active research section fitted to give authoritative opinions on these matters.

Having regard, however, to their limited establishment, we would draw attention to the important research which has already been effected by the Standards Office. After investigating stresses in rails and fish-plates, their officers have been dealing with the more difficult problems of disturbance in the track, as set up by "X" class "Pacific" engines; a description of their work is included in this chapter. It will be seen from our recommendations that we consider that this essential work be continued; indeed, without it, our recommendations could not have been made so confidently, having regard to all the prevailing circumstances.

Investigation in Other Countries.—As a preliminary to describing and discussing the work which has been carried out in India, we think it may be of assistance to give a summary of the investigations which have been undertaken in other countries. Since the origin of railways, the study of the reactions between engines and track has led engineers to undertake experiments and research.

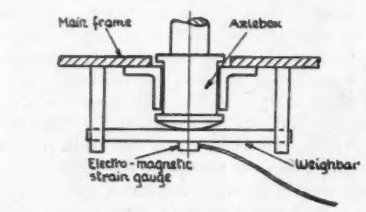
Problems have arisen from time to time, generally either after accidents, or after defects so frequently reported as to be regarded as epidemic. Special investigation has usually been suggested and put in hand, but it has sometimes happened that modifications have simultaneously been made to rolling stock or track, which have removed the causes of trouble before the investigation has been carried to any definite conclusion. In other cases, the development of suitable experimental equipment has either taken a long time, or has never been perfected, and the matter has lost its interest before the research has been carried to finality. It is for reasons such as these that experiments on track and vehicles appear from time to time in the annals of railways as uncompleted investigations.

It is also true to say that such tests have not been carried out to an equal extent throughout the world because some countries did not find them necessary, in view of favourable conditions in respect of rigidity of track and of design characteristics in rolling stock. Brief descriptions follow of the extent to which research has been effected in America, Germany, France, South Africa, Great Britain, and India. These refer particularly to the practical experimental work which has been undertaken. References to theoretical investigations are contained in Chapter III.†

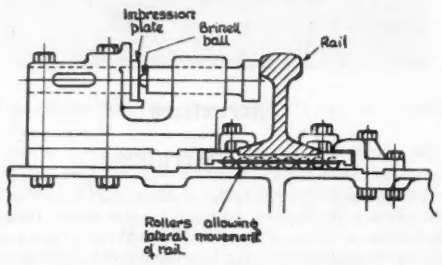
America

References.—In America, the most important investigations into this subject have been those carried out by the Pennsylvania Railway. Through the courtesy of Mr. F. W. Hankins, assistant vice-president, chief of motive power, on that railway, we were provided with a description of the apparatus used, and articles on these tests have appeared in the Technical Press.[1] The object was the determination of flange forces exerted by locomotives, and this was effected mainly by measurements made on the track.

In addition to the above, a special Committee on stresses in track has been set up by the American Railway Engineering Association, in co-operation with the Association of American Railroads and the American Society of Civil Engineers. Field work for this Committee included tests for rail joint and track stresses on the Pennsylvania Railway, and tests of continuous welded rails.[2]



ARRANGEMENT OF WEIGHBAR & ELECTRO-MAGNETIC STRAIN GAUGE FOR MEASURING FLANGE FORCES. (Stresses applied to locomotive with outside frames and axleboxes)



METHOD OF RECORDING FLANGE PRESSURES BY MEANS OF SPECIAL RAIL FASTENING.

AMERICAN EXPERIMENTS.

"THE ENGINEER"

FIG. 1

Method Adopted by the Pennsylvania Railway.—Flange forces are determined by introducing a length of special track, on which, under the action of these forces, the rails are pressed laterally against strips of steel; impressions in the strips are made by Brinell balls at close intervals, and their dimensions are a measure of the magnitude of the forces involved. This method was first used as far back as 1907. With the continued increase in speed and weight of locomotives, it was subsequently adopted for investigations in 1910, 1912, and 1924 at various locations on the railway. The most comprehensive tests, however, were started in 1933 and continued for two years, the particular problem arising from the introduction of high-speed electric locomotives.

Description of Apparatus.—The special test track, which may be laid down at any point, is 440ft. long. Existing rails are used, but they are laid for the length of the test section on 249 metal sleepers, every other one of which is fitted with apparatus to measure and record the lateral thrust against the rail. The recording apparatus uses a hardened steel ball to make an impression in a soft steel plate. The impression made by a Brinell ball varies with the force applied; moreover, the use of this apparatus is of value, because, if the ball is subjected to repeated blows of varying magnitude the impression is the same as it would have been under the maximum blow.

At both ends of each recording sleeper, plungers, which are free to move longitudinally in their bearings, press against the heads of the rails. A hardened steel ball, 1in. in diameter, is placed at the opposite end of the plunger, and bears against a piece of annealed boiler plate supported by a suitable bracket. This impression plate is brought into contact with the ball by another plunger, which is driven up by a wedge. When a locomotive passes over the test track, the lateral blows from the wheels force the hardened steel ball into the soft steel plate, and the diameter of the impression gives a measure of the force of the maximum blow at each recording sleeper. When the test track is not in use for trial purposes the balls and impression plates are replaced by the flat dummy plates; the plungers are then driven up against the rail and the wedges are held in place by tightening the set screws.

At each sleeper both recording and non-recording, the rails are supported by roller bearings, which offer negligible resistance to the lateral movement of the rail. If rail inertia and the small amount of friction of the roller bearings are disregarded the only forces resisting the outward movement of the rail are those passing through the Brinell ball. The impression plates must therefore record the maximum force required to resist the outward movement of the rail when lateral blows result from the passing of a locomotive. These plates are of ¼in. boiler plate, annealed after being cut to size; they are finally ground smooth on the side where the impressions are to be made. A correction is necesasry for any variation in hardness in the plates themselves. Fig. 1 shows this arrangement.

The speed at which the locomotive passes over the test track is measured by a chronograph. A paper drum is driven by a constant-speed motor, and half-second intervals are marked on the paper from a clock. The position of the engine as it passes over the track is recorded on the paper by the action of circuit breakers, which are operated by an arm attached to the locomotive severing a wire at the top of the breaker. The circuit breakers are placed 146ft. 8in. apart, so that at a speed of 100 m.p.h. the length between marks on the paper equals the length between second marks.

It will be noted that tests carried out with this apparatus are confined to one short piece of track. In order to extend the tests to any part of the line the electric locomotives were fitted, in 1933, with strain gauge recorders attached to the axle-boxes. These were modified so that the force between each axle-box and the locomotive frame was taken through a rigid weigh bar of chrom-nickel steel. The stresses in these bars were measured by electro-magnetic strain gauges recording on oscillographs. A weigh bar was placed at each end of the axle, which was free to move between the two bars with its normal clearance in the frame. The two strain gauges corresponding to each axle were interconnected electrically, so as to record on a single line on the oscillograph; deflection was upwards for force towards the left rail and downwards for force towards the right. The gauges were operated on a 2000-cycle current and were calibrated statically in a testing machine. This method of recording flange forces was developed only for electric locomotives having axle-boxes and frames outside the wheels; it was not applied to steam locomotives.

Results of Tests.—In the latest series of tests, in addition to different types of electric locomotive, a standard Pennsylvania "K.4S" type "Pacific" steam locomotive was tested, and in general the latter produced lower lateral forces on the track at high speeds than did the former engines. The maximum thrust of the "Pacific" against the rail at different speeds on the straight was as follows:—

M.p.h.	Tons.
50	6·7
60	7·6
70	10·2
80	11·2
85	11·6
90	10·2
95	11·2

These forces were exerted on a track laid with 131 lb. F.F. rails, by unidentified wheels of a "Pacific" engine, which weighed 138 tons, had a total wheel base of 36ft. 2in. (rigid 13ft. 10in.), and had a swing link bogie with a hind pony truck. The results were considered to be satisfactory in relation to the weight of engine and type of track, and the whole of the two years' testing was concentrated on lowering the flange forces exerted by the high-speed electric locomotives to values of approximately this order. No special tests were made with a view to reducing the forces for this particular steam locomotive.

With regard to the electric locomotives, it is interesting to note that one of the principal modifications made was to alter the side control of the bogies from the type commonly used. Instead of having a relatively small initial control, subsequently rising in direct proportion to the lateral displacement, an

* Being Chapter VII of the Report of a Committee on "Pacific" Locomotives on Indian Railways. India Office. Price 6s. 9d. Some of the diagrams have been omitted owing to the impossibility of reduction.

† See THE ENGINEER, July 21st and 28th.

[1] *Railway Age*, September 12th, 1936, page 374; September 19th, 1936, page 412.

[2] *Railway Age*, June 25th, 1938, page 1042.

arrangement of control was adopted giving three times the initial value, which, after a lateral displacement of 1in., gradually reduced in intensity with further displacement. At the same time, the rotation of the bogies was restrained by a system of radius bars. The effect of these modifications on a particular class of electric locomotive was to reduce the lateral thrust by 40 per cent. at 70 m.p.h.

American Railway Engineering Association Tests.—These track tests were carried out at speed up to 90 m.p.h., and under a variety of conditions. Magnetic strain gauges of normal type were employed for the measurement of both strains and stresses; new types were, however, developed to deal with strains, of exceptional magnitude. All the tests were made on 131 lb. F.F. rails, with fish-plates of different types and conditions, representing variations in section from nearly rectangular to L shape, including those with controlled bearing surfaces and head-free bearing. Observations recorded by oscillographs included stresses in the rail adjacent to the joint, stresses at different points in the fish-plate, vertical and longitudinal movements between rail head and fish-plate, and vertical depression of the rail between and at joints.

The strain gauges were of a similar kind to those on the locomotive flange force weigh bars. For recording rail depression special gauges were used; they consisted of a coil attached to a fixed reference, independent of the rail, and a core attached to the rail, moving within the coil. The change in current in the coil varied with the amount of movement of the core, this being recorded on the oscillograph film with a magnification of 4, thus permitting measurement of larger movements than is possible with other gauges. Additional tests have been carried out to ascertain the effect produced by battered rail ends, by flat wheels, by excentrically mounted wheels, and by counterbalance of locomotives. The above brief *résumé* indicates the lines on which investigation is being conducted, but the tests and analyses of result have not proceeded far enough for definite findings to be published.

General Remarks.—It is noteworthy that for thirty years the American railways have been aware of the effects of high flange forces, and have designed apparatus to measure them. Intensive use of the Brinell track equipment has been made in recent years in connection with problems arising from high-speed electric locomotive operation. It would appear that the heavy steam engines in operation in America exert flange forces of some magnitude, but, having regard to the axle loading and the requisite weight of rail with close sleepering which is common, such forces up to 12 tons do not give rise to track distortion. The track tests which are now being carried out are more concerned with improvements in the strength of track itself, with a view to decreasing vertical deflections under load. We have found no record of tests carried out to measure the lateral resistance of track as a whole to given flange forces.

GERMANY

As long ago as 1869 Von Weber[3] studied the reaction of the track to the passage of rolling stock by recording axle movements, amplified by suspension springs. The natural periods of the springs, however, prevented conclusions of practical importance being reached. Since that date there have been numerous investigations and a great deal of mathematical work has been carried out.

In 1928, owing to inability to reach definite conclusions as to the cause of certain express train derailments which had occurred during a short period, a commission was set up[4] by the German State Railways, composed of certain of their own officials, in collaboration with the engineering section of the Heinrich Hertz Institute, Berlin. After studying the theoretical aspects of the problem, the Commission decided that a true picture of the situation could be obtained only by practical experiment. The aspect with which they were primarily concerned was the relationship between flange forces and wheel loads, particularly on leading axles. They recognised that such forces were built up of both statical and dynamical components, and it was the impossibility of assuming any reliable value for the latter which necessitated the subsequent long series of practical trials.

The most important requirement was to make a continuous record of the amplitude of oscillation, and to measure simultaneously the magnitude of the lateral forces exerted by the leading axle and the vertical loads bearing on it. While instruments then existing were capable of measuring displacements and forces, they were unsuitable for fitting to locomotives. It was necessary therefore to devise special apparatus for this purpose, a process which occupied a considerable time.

For measuring pressures, use was made of carbon blocks.[5] Blocks of carbon have the property that, when subjected to pressure, their electrical contact resistance alters. Under constant voltage, the flow of current, recorded by a suitable device, is proportional to the pressure applied. As, however, carbon is not mechanically strong enough to stand a load greater than 400 lb. per square inch, it is necessary for the blocks to be placed in a flexible steel housing, the top of which is in direct contact with the load to be measured (Fig. 2). This has the effect of by-passing a definite proportion of the total load supplied. No amplification stage is necessary in the circuit between the carbon pressure unit and the recording element, and this method was used in preference to that of the quartz crystal (piézo-electric), owing to the fact that the latter required amplification in two stages, with much attendant complication. As the carbon elements could be made small in size, they were easy to apply without structural alteration to the parts of the engine.

For measuring displacements, an instrument was used containing an insulated resistance wire, bent into the form of a circle, contact with which was made by an arm mounted on a spindle. On the extreme end of this spindle a pulley was fixed, which was actuated by a wire from the part whose displacement was required. Any displacement therefore caused the pulley to rotate and the contact arm to make contact at different points along the circumference of the resistance wire. The varying resistances so obtained were then transferred to an oscillograph.

The foregoing elements for measuring forces and displacements were mounted on the engine, but the recording apparatus and necessary oscillographs were placed in a special van immediately in rear. The recording was effected on revolving drums of paper, which were driven from the road wheel. Later it

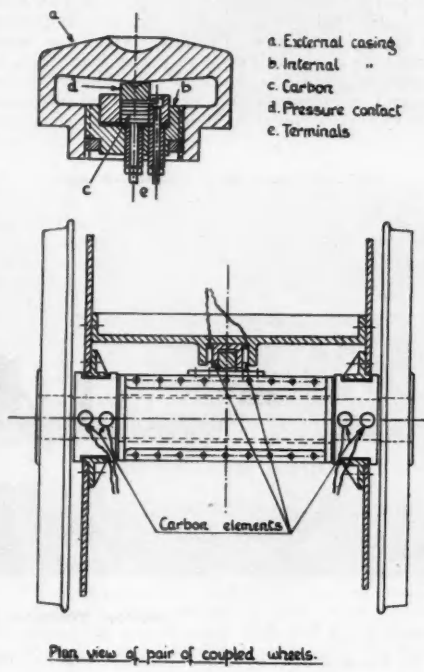


FIG. 2

was possible to use cathode ray oscillographs for the same purpose. Accelerometers were also developed, in order to ascertain the inertia forces of the unsprung weights on the different wheels under test.

The Commission which undertook the above-mentioned investigation was dissolved in 1933, after completing work on certain definite terms of reference; but it was felt that there remained a very big field for research and that continuous experiments were still required. A new research section therefore was formed at the end of 1933, primarily to deal with the safety of vehicles at high speeds. A new recording van was specially constructed for this purpose, with instruments capable of measuring and recording simultaneously the necessary displacements and flange forces on all the axles of a locomotive.

Through the courtesy of Dr. Dorpmüller, Minister of Transport and General Director of the German State Railways, we have received certain information, of which the following is a translation, giving particulars of the principal tests which were carried out, and the results obtained:—

"Briefly the present arrangement of the measuring instruments is as follows:—

"Three Siemens and eight pen oscillographs to which are connected twenty-four measuring points, are accommodated in a test car. In addition, there are thirty resistances for the carbon elements and six for displacements, ranging up to 400 mm. (15¾in.) and from 0 mm. to 80 mm. (0in. to 3⅛in.). The pressure elements are suitable for loads of 5, 10, and 15 tons, and the displacement meters for large or small movements. These instruments have been built and developed by the locomotive research section, and are to-day capable of satisfying all requirements.

"For axles with outside journals, the elements for measuring vertical loads are placed between the axle-box and the bearing brass, or between the axle-box and the spring buckle. Elements for measuring the side pressures are fitted between a bearing plate and the axle journal. Axles with inside journals have the vertical measuring elements placed between the spring buckle and the axle-box, while, for measuring side pressures, a distance piece, split in two halves, is fitted round the axle, and rotates on two rolling rings. The ends of this distance piece are white metalled, and a rigid pin is connected to the main frame through the intermediary of carbon measuring elements (see Fig. 2). By these methods it is possible to measure the vertical and horizontal loads which are exerted on all the important axles. At the same time, measurements are taken of displacements, such as those existing between the bogie axles and frame, and the movement between the locomotive and tender, &c. Up to now many different types of locomotives and vehicles have been tested, but I think that probably the results of the tests on the "Pacific" locomotives, Class "O 3," would be of particular interest to you. This locomotive, which is to-day the standard engine of the German State Railways for light and express "D" (through) trains has been fully tested. The results are of particular value, as they have given us information not previously known.

(*a*) *Running on Curves and the Determination of Super-elevation.*—It has been the policy during the last few years to increase running speeds, and one of the first essentials of this must be a good permanent way. Critical places on the track are where the rails leave the straight, and enter curves and points; to obtain a smooth and free running, every curve must be super-elevated sufficiently to take into account the centrifugal force, and it must also contain a transition curve at its commencement. The curve with the full amount of super-elevation is connected to the straight track by a transition curve, which, in order to reduce side pressure, must be of a definite length. At the same time, the variation in super-elevation must not be too great, in order to avoid excessive loading and unloading of individual wheels. It was, therefore, necessary to ascertain the highest permissible speed at which running could safely take place, and numerous experimental runs have been carried out with varying curvatures, super-elevations, and speeds.

Experimental runs were also conducted over curves at a speed 40 per cent. in excess of that permitted in service, in which case the centripetal force was affected not only by the increase in super-elevation of the rail, but also by the effect of flange pressures. These pressures exceeded all expectations; for instance, at a speed of 156 kiloms. per hour (97 m.p.h.), where the permissible speed was 110 kiloms. per hour (68 m.p.h.), the flange pressure on the leading coupled wheels was in the neighbourhood of 15 tons, vertical pressure on the outside axle-box being between approximately 9 to 10 tons, and on the inner axle-box approximately 3 tons. The results of the whole series of tests show that the leading bogie axle has practically the same side pressure at all speeds, whereas the variation in vertical bearing pressure increases with increase in speed. At low speeds, flange pressures on the leading coupled axle are obtained only on the inner wheel on curves, this being due to the force of gravity, owing to the inclination of the track. With increasing speed this pressure is diminished until the point is reached where the pressures alternate equally between the outer and inner rails. With an increase in speed the whole of the flange force occurs at the outer wheel, and increases rapidly as speed rises.

The vertical load on the leading coupled axle has similar characteristics; for example, at low speeds, there is decreased load on the outside wheel and increased on the inside. At the point of balance, the two loads are equalised, while, with an increase in speed there is increase of load on the outside wheel and reduction of load on the inside wheel. The best running is therefore obtained at the balancing speed where the minimum pressure changes occur. Furthermore, with an increase in speed, the pressures, and thereby the stresses in the vehicle and the track, increase the danger of derailments. For any increase in speed the super-elevation must be increased correspondingly, since for high speeds the track must be satisfactory owing to the fact that any small disturbance reacts immediately on the running of the vehicle.

In order to examine the matter further, tests were conducted on curves having considerable super-elevation, and also on reverse curves without a straight piece of track joining them; new ideas on the subject were ascertained from the tests which were carried out on the "03" class "Pacific" at the maximum permissible speed for that class of engine, *i.e.*, 80–100 kiloms. per hour (50–62 m.p.h.). The maximum flange pressure recorded on the leading coupled wheels was 18 tons, and the vertical bearing pressure

[3] "Die Stabilität der Eisenbahngeleise" ("Stability of Permanent Way"), by Freiherr Von Weber.

[4] *Glasers Annalen*, December 1st and 15th, 1935; *Organ für die Fortschritte des Eisenbahnwesens*, October 1st, 1934.

[5] *Verein Deutscher Ingenieure*, 1937.

9 to 10 tons. It cannot be said that these figures afford a sufficient factor of safety; but it should be realised that such high values only occur during a fraction of a second, and the flange does not have time to react unfavourably. The flange pressure on the leading bogie wheels varied on these tests between 0 and 4 tons, and this only on the outer wheel. It was natural that with these high coupled wheel flange pressures there would be considerable changes in the vertical wheel loads; on the bogie they were of the order of ± 3 tons and on the coupled axle $\pm 2 \cdot 5$ tons.

For the "03" class "Pacific" engine with the existing control spring, it can be stated that:—

(1) The bogie does not exercise sufficient controlling effect on the guiding of the engine when running on curves.

(2) The leading coupled axle is at a shorter distance from the vertical axis through the centre of gravity than is the leading bogie axle, and for a given turning effect on the engine, a higher flange force will have to be exerted at the former than at the latter. For this reason it is the leading coupled axle, and not the leading bogie axle, which is the source of greatest danger.

(3) The flange pressures on the bogie are practically independent of speed.

(4) The friction of the slides is not sufficient to make for steady running of the bogie.

(5) To increase the guiding force of the bogie, it will be necessary to fit stronger control springs.

The most important point arising from these tests was the knowledge that this bogie, with an initial control spring load of 1750 kilos. (1·72 tons) did not provide the necessary guiding force required, although it had been considered to be sufficient on purely theoretical grounds; moreover, when running over a curve, unequal reactions were obtained at the inner and outer rails. It was therefore decided to increase the initial load of the control springs to 3500 kilos. (3·44 tons), and the results on the same locomotive with this new spring, running on the same track, were as follows:—

(1) The displacement of the bogie in relation to the main frames was somewhat less with the strong springs than that obtained with the weak springs.

(2) The centring force and flange pressures on the leading bogie axle were correspondingly greater with the strong springs than with the weak springs.

(3) The flange pressure on the leading coupled axle at a given speed was somewhat higher on the inside rail when the stronger spring was fitted, but was noticeably lower on the outer rail. This means that, with the stronger spring, speed can be increased by 10 kiloms. to 15 kiloms. per hour (6·2 to 9·3 m.p.h.) before the flange pressures are equal to those obtained with the weak springs.

(4) The changes in vertical loads were not materially affected by the use of stronger springs.

(5) The fitting of stronger springs did not increase the hunting effect and the speed at which serious hunting commenced was definitely lifted.

It is not thought necessary to quote all the many numerical values of the test results, as the size of the loads is dependent on the varying speeds and radii of the curves. Further experiments have been conducted with the "03" class "Pacific" locomotive travelling over turnouts without super-elevation.

(*b*) *Travelling Over Points and Crossings.*—The experiments were conducted over turnouts (German State Railways design 8A) having radii of 500 m., 300 m., and 190 m. respectively (1640ft., 985ft., and 624ft.), and, as had previously been discovered, the highest flange pressures obtained were on the leading coupled axle. It is clear that the load changes from one wheel to the other on a reverse curve, and this transfer of load increases rapidly in value with increase in speed. It has been found that the guiding force of the bogie fitted with weaker controlling springs is very low when travelling over turnouts, and speed could not be raised above that at present permitted, 45 kiloms. per hour (28 m.p.h.) on curves having radii of 300 m. and 190 m. (985ft. and 624ft.).

(*c*) *Measurements Taken on Springing and Compensating Gear.*—You will be aware that the friction between the spring plates and the equalising links plays only a very small part. Measurements of vertical wheel loads on engines fitted with compensating gear indicate that the loads on the coupled axles are equally distributed. Tests were, however, conducted with engines having both compensated spring gear and individual wheel springing, in order that comparisons could be made between the two systems; it was found that the variations in loads were about 60 per cent. less with the former arrangement than with the latter.

When running over rail joints the sudden reduction of load is particularly severe with individually sprung wheels; while with compensating gear the peaks of maximum load are flattened out considerably, owing to the fact that any change of load due to unevenness in the track is transmitted on to the other axles. It can be said that, due to vibration when running, the effect of friction in the springs and equalising links does not have any noticeable effect.

With the above conclusions and test results the experiments conducted on the "03" class "Pacific" locomotives were brought to a close.

With reference to the influence of the track on the running of locomotives, it can be stated that, generally, the majority of engine types do accommodate themselves satisfactorily when the track is in good condition. Naturally, a badly laid track has a definite influence on the running of the locomotive. The experiments on the German State Railways have shown that those types of locomotives having only coupled axles, with their correspondingly heavy overhanging loads, exert high flange forces on the leading axles and do not therefore run as smoothly on bad tracks (such as on secondary lines) as engines fitted with a bogie. This occurs in particular at high speeds when, of course, high stresses are set up in the track. Locomotives having a guiding axle in the form of a Bissel truck did not fully satisfy the requirements relating to the necessary guiding forces; the truck had no material effect on the guiding of such engines as originally designed. It is therefore the intention of the German State Railways to replace the Bissel trucks on those engines noted for bad running by the Krauss-Helmholtz bogie, which has better guiding properties.

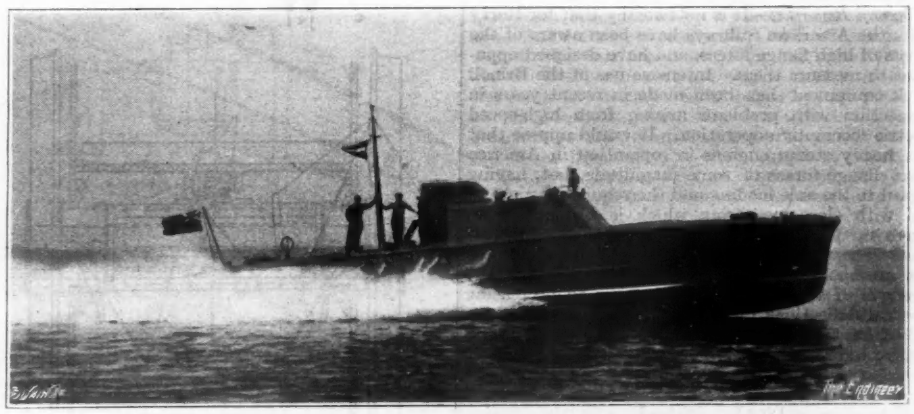
Tests conducted on an electric locomotive have also confirmed that the forces brought into play are of a similar order, and that all the results obtained depend upon the mass of the locomotive and the arrangement of the axles. In conclusion, it should be emphasised that the testing methods described have given reliable results, and have been of assistance not only to the Chief Mechanical Engineer, but also to the Civil Engineer, in obtaining improved running of vehicles on the track.

(*To be continued*)

A High-Speed Motor Torpedo Boat

No. I

ON Friday last, July 28th, we were invited to be present at demonstrations in Southampton Water of a new type of fast torpedo boat, which has been developed by Aero-Marine Engines, Ltd., of Pall Mall House, 28, Pall Mall, London, Minerva Shipyard, East Cowes, and Paris. The boat, which has been designed for a speed of over 45 knots, and which is illustrated herewith, is one of an order for twelve for a foreign Government, eleven of which were entrusted to the Chantiers Naval de Meulan on the Seine, and one to Frank Curtis, of Looe, Cornwall, which is the boat demonstrated and herewith illustrated.



MOTOR TORPEDO BOAT DURING TRIALS

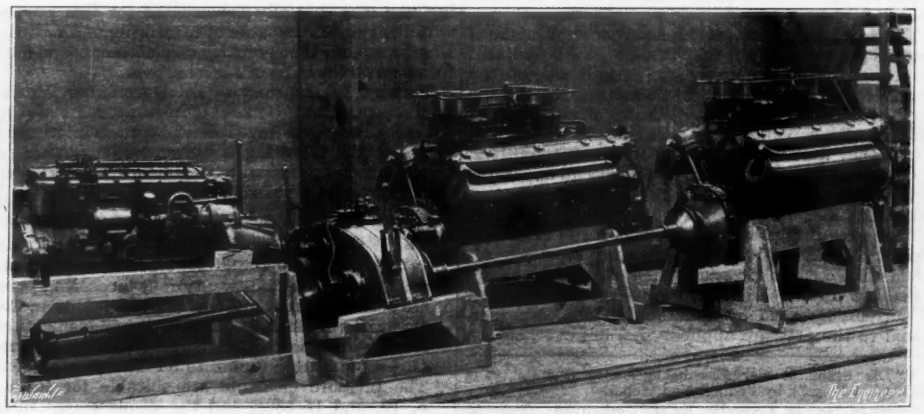
The principal particulars are as follows:—

Length	20·00 m.
Beam	4·52 m.
Moulded depth amidships	2·43 m.
Draught	1·2 m.
Average displacement	30 tons
Engines—main: Four twelve-cylinder Aero-Marine Lorraine, 600/690 S.H.P.	
Engines—auxiliary: Two eight-cylinder Lycoming 100 S.H.P.	
Maximum speed on four main engines	Over 45 knots
Radius of action on four main engines	176 sea miles
Cruising speed on two main engines	27 knots
Radius of action on two main engines	325 sea miles
Cruising speed on two auxiliary engines	10 knots
Radius of action on two auxiliary engines	650 sea miles
Crew	Six, two officers and four seamen

The hull is of the vee bottomed type, timber built throughout, and it is subdivided into seven compartments, five of the bulkheads being fire and waterproof. The system of construction embodies a triple-skin mahogany bottom with double-skin sides, with a deck and a wheel house. Closely spaced oak frames are employed, with specially strong gunwales and chines, and, together with laminated type engine beds, they give, it is claimed, ample strength with sufficient elasticity when running at high speed under severe weather conditions.

A general view of the boat at speed during demonstration trials is given herewith, and also a view of one set of the twin screw arrangement of propelling machinery.

For purposes of main propulsion each of the twin screws is driven by a pair of French built Lorraine petrol engines, which are rated at 600 to 690 S.H.P., when running at 2300 to 2400 r.p.m. Each engine is fitted with a Cotal electro-magnetic clutch, and, as will be seen from our engraving, they both drive to a water-cooled gear-box. On the after side of the gear-box there is arranged a Lycoming 100 S.H.P. petrol engine with an integral reverse gear. This engine can be used for cruising at a moderate speed, for manœuvring or for starting the main engines, if desired. The bilge pumps and electric generators are also driven from the main gear-box, and there is also an air compressor for starting purposes. In addition, each main engine is fitted with an air compressor, so that starting air is always available. The



ARRANGEMENT OF ONE SET OF MAIN AND AUXILIARY ENGINES

"Viet" starting system is employed. Each main engine has its own oil and fresh water coolers, in addition to the oil coolers incorporated in the lubricating system for the gear-boxes. The main engines are cooled by fresh water, and the auxiliary engines are supplied with sea water cooling, and all exhaust piping is water cooled. Access to the main engine-room is by a hatchway. The main instrument board is equipped with a complete set of electrical and mechanical instruments, together with a light signal system connecting the control board at the navigating position to the engine-room. On the aft bulkhead there are arranged the fuel cocks and filters, which are connected to the main fuel tanks immediately aft of the bulkhead. There are two navigating positions, one in the wheel house and the other at a slightly elevated position aft, the steering wheel, navigating and control instruments being provided in duplicate. The general design of the boat allows for the provision of suitable armament, to which we shall refer in a later article.

In the able hands of Flight-Commander Claude Graham-White, one of the directors of Aero-Marine Engines, Ltd., and later those of Captain George Eyston, the demonstration trials were carried out with every success. At a luncheon which took place at the Polygon Hotel, Southampton, before the trials, it was announced by Mr. Claude Graham-White that on the previous day trials had been carried out under Admiralty conditions, and a maximum speed had been obtained over the measured mile in Stoke's Bay of 45¼ knots, with a load 2 tons above the normal. These trials were specially made for Admiralty representatives.

(To be continued)

An Improved Drilling Machine

A NUMBER of improvements have recently been incorporated in the range of "Type V" self-contained, all-electric drilling machines made by Alfred Herbert, Ltd., of Coventry. These machines are available with one, two, three, four, or six spindles mounted on a common base, each spindle being plain or geared, and having either hand or automatic feed. The general arrangement of a four-spindle machine may be seen in the accompanying engraving.

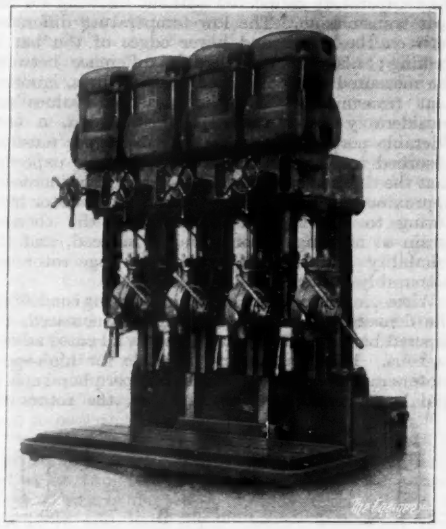
The drive is from a rotor stator unit mounted on the top of the column, driving directly the spindle on the ungeared machines, and through the medium of a pair of back gears giving an additional slow-speed range on the geared machines. Machines with plain spindles are capable of drilling up to ⅝in. in steel and 1in. in cast iron, while the machines with geared spindles will drill up to 1in. in steel and 1¼in. in cast iron. Maximum sizes of holes which can be tapped are ⅝in. in steel and 1in. in cast iron on the geared spindle machines.

Speeds are selected by means of an easily rotatable star wheel, which operates a butt contact switch mounted in a housing below and to the rear of the motor. This type of switch, which has been particularly designed for the work, has the advantage that sparking between the contact fingers is considerably reduced, thus ensuring freedom from wear and pitted contacts. Reversing is effected by a separate finger-operated lever behind the change-speed wheel, and operation is such that the reverse may be used as an effective brake, arresting the spindle almost instantaneously. Inspection and maintenance of these switches is rapid and simple, as provision has been made to allow the whole of the switch to be drawn out of its housing to the rear of the machine.

Four speeds are provided on machines having a plain spindle. The number is increased to eight on the geared machine through the medium of the pair of back gears enclosed in a gear-box below the motor. Selection of the fast and slow range of speeds is effected by a small lever mounted on the right-hand side of the gear-box.

In the improved type of machine, the spindle sleeve has been enlarged considerably, and the width of the rack teeth has been increased. Engagement of the automatic feed is now done by the sideways movement of the feed lever, and the feed can be arranged to trip either automatically or by hand. Another feature of the improved feed mechanism is the stop arrangement which will permit of a lengthened stroke, allowing for more than the usual one revolution of the feed pinion.

The electrical control gear is mounted in a self-contained unit on the bottom column and consists of an interlocked isolating switch having three fuses and a push-button-operated contactor starter to provide "no volt" protection. All wiring is arranged internally, and by the use of a special terminal plate inside the rear of the bottom column, the wiring may be easily disconnected to permit the quick and easy removal of the top columns.



MULTI-SPINDLE DRILLING MACHINE

A motor-driven pump is supplied as an extra, and when fitted is controlled by a rotary switch protected by magnetic overloads, all of which are incorporated in the main control panel.

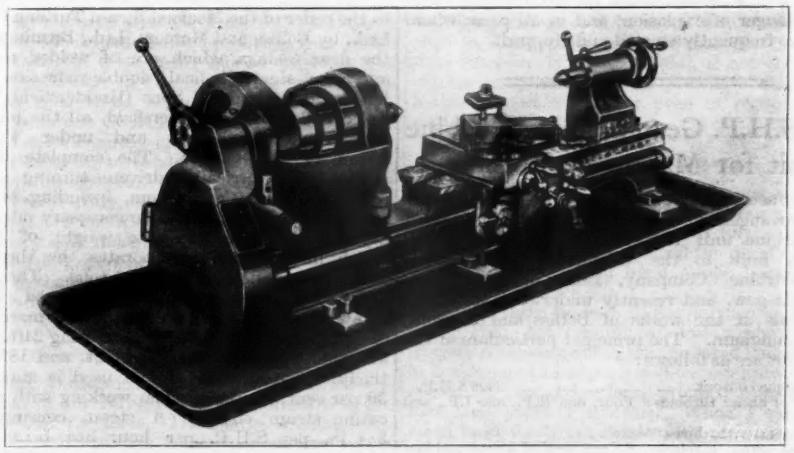
Tool-Room Lathe

IN the accompanying engraving we illustrate a new 4in. centre lathe manufactured by the Myford Engineering Company, Ltd., of Neville Works, Beeston, Notts. Designed for tool-room use, the lathe is in several particulars different from the standard range of machines made by the firm. As is shown in the engraving, it is sturdily built and has a pleasing appearance. It is provided with a double-walled apron housing the traversing gears for the saddle. Contained in the apron is an oil bath, which supplies lubricant for the centralised oiling system. The rack-traversing motion is geared, and consequently the saddle traverses in the same direction as the rotation of the handle. A machine-engraved steel dial, with knurled finger-grip and knurled screw for quick setting is fitted to the feed screw of the cross slide, and an easily operated knurled lever controls the spring-loaded tumbler reversing gear. Rigidity is secured in the mounting of the top slide by adopting a three-point carriage.

A flush thread dial indicator, as fitted on large industrial machines, is mounted at a convenient angle, and for its disengagement a knurled locking post is provided. Controlled by a toggle clutch and a long handle, the back gear slides in and out of engagement, as can be seen in the illustration.

Between the ways is mounted the tail stock with which is incorporated a quick-release mechanism claimed to be instantaneous in action. It is operated by a long handle from the front of the lathe. For the change wheels an aluminium guard is used, and other parts, such as the back gears, are neatly and effectively covered by guards.

Instead of the top slide shown, a heavy square steel turret can be supplied, and a new type of collet chuck with ⅝in. capacity is also available.



TOOL-ROOM CENTRE LATHE

Wedge Bar Squirrel Cage Rotors

EFFORTS to improve the starting performance of the ordinary squirrel cage motor with the object of making it more generally applicable, have resulted in the production of various machines, often lacking the original simplicity of the ordinary squirrel cage motor. But on the whole only motors with the double cage rotor and deep bar rotor have held their own. A more recent addition to high starting torque motors is a machine with a wedge bar rotor, made by the A.E.G. Electric Company. As it readily adapts itself to different starting conditions, the double cage rotor occupies a prominent position. This adaptability is based on freedom in the proportioning of the stray flux and of the running and starting windings which can be chosen independently of one another.

But where the starting conditions can be satisfied by the deep bar or wedge bar rotor, a more simple construction is possible. The deep bar rotor winding (Fig. 1*b*) consists of thin deep bars connected together by rings. Improvement in the starting characteristics is attributable to the fact that the transverse fields of the slots induce eddy currents in the solid

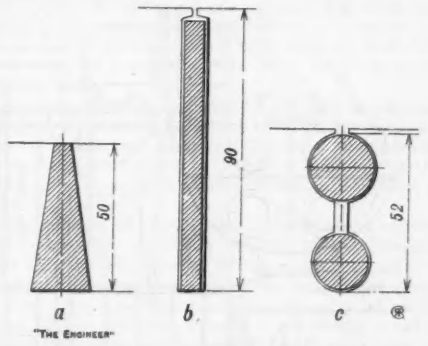


FIG. 1—WEDGE BAR, DEEP BAR, AND DOUBLE CAGE

rotor bars, resulting in an uneven distribution of the current throughout the cross section of the bars, so that the current is displaced towards the upper end of the bar. The non-reactive resistance of the rotor winding, and hence the torque, are therefore greater than when the current is distributed uniformly throughout the bar. This effect increases with the frequency, as well as with the height of the bar, and is therefore a maximum when the rotor is stationary because the rotor frequency is then the same as that of the supply.

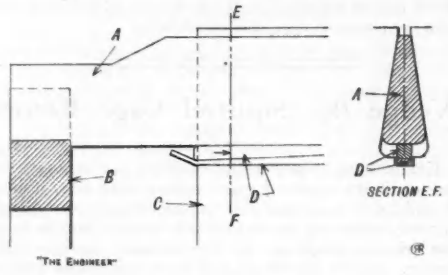
Although the deep bar rotor represents a useful solution of the problem, if a particularly high increase in resistance is necessary for attaining a predetermined starting torque, the bars have to be very deep and narrow, as in the case, for instance, with large-capacity and high-speed motors. Bars of such a shape may not only result in unfavourable conditions with regard to heating when starting, but may also increase the difficulties of assembly and of securing a satisfactory connection with the end rings. But the A.E.G. wedge bar (Fig. 1*a*) is claimed to obviate these disadvantages.

The manner in which it operates is fundamentally the same as that of the deep bar rotor. But the wedge-shaped cross section of the bars, when compared with that of the deep bar rotor, has the important advantage of combining the simplicity and reliability of the single cage rotor with favourable electrical and mechanical properties. On starting the motor, the skin effect is greater than with deep bar rotors. For the same depth of bar, and otherwise the same conditions, the wedge bar rotor develops a greater starting torque or conversely the depth of the bar may be less for the same starting torque. In Fig. 1 the three-bar constructions, viz., wedge, deep bar, and the double cage rotor with bars of the same cross section and the same skin effect properties are compared.

The wedge bar also permits of greater freedom in the design of the rotor winding. Whereas in the case of the deep bar, for a given cross section, it is only possible to vary the width of the bar, with the wedge bar the ratio of the width of the bar at the top to the width at the bottom can also be varied. Hence it is possible to adopt the wedge bar rotor very closely to the existing starting conditions. Among the chief

advantages of the wedge bar from a mechanical standpoint is the firm adherence of the faces of the bar to the sides of the slot, thus ensuring a secure seating.

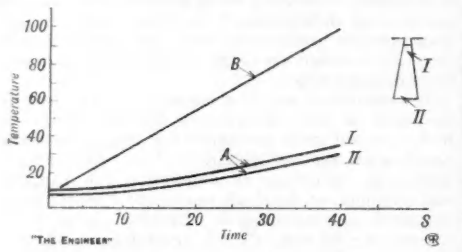
In the case of high-speed motors of considerable outputs, the task of fixing the rotor bars is sometimes difficult. Wedge bars can, however, be inserted into the slots without force and then be pressed tightly in the tapered slots by means of axial wedges, as shown in Fig. 2. This wedging, which is generally



A, wedge bar; B, ring; C, stampings; D, wedges.

FIG. 2—WEDGE BAR CONSTRUCTION FOR LARGE HIGH-SPEED MOTOR

only necessary with bars of considerable cross section or when the peripheral speeds are high, gives a good fit to the bars and the stampings and causes the bars to be applied evenly over the entire surface of contact, thus ensuring absolute reliability in operation. The uniform and firm application of the wedge bars in the slots is of considerable importance from the point of view of the transfer of heat from the bars to the rotor iron. Such heat transfer with a wedge bar rotor is always good, and is particularly desirable as regards the heating of the squirrel cage rotor at starting. The heat produced on starting depends on the inertia and frictional resistance to be overcome. The temperature rise of the rotor winding is given by the following relationship, $t = \frac{A}{C\,G}$, where A is the starting-up heat, C the specific heat of the rotor winding, and G the weight of the rotor winding.

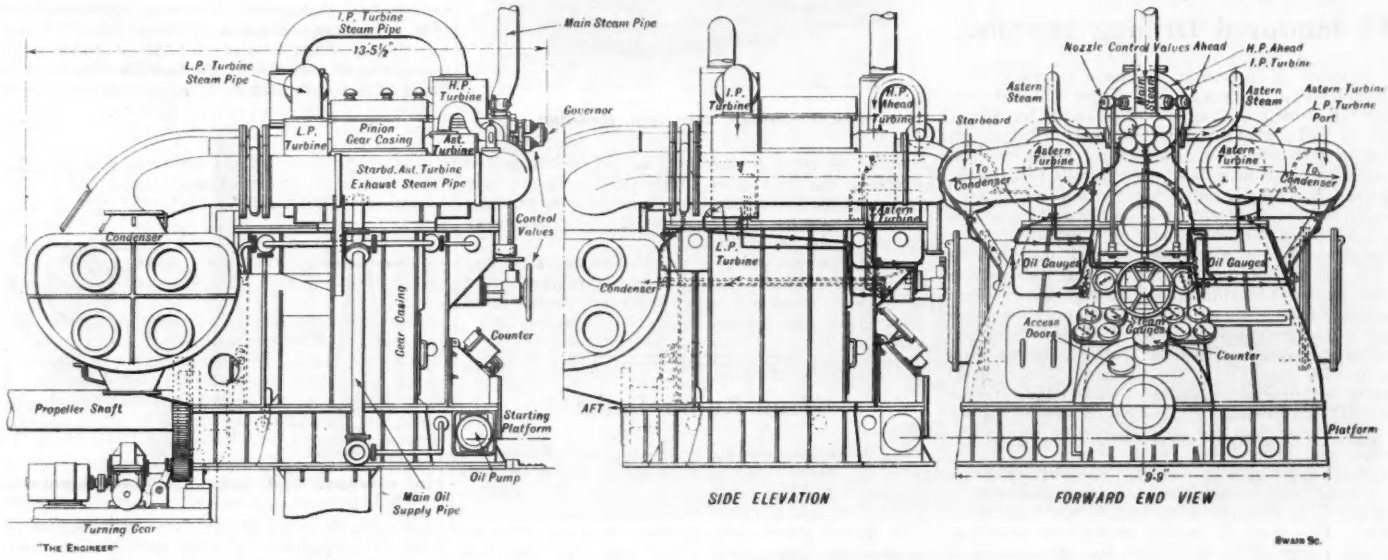


A, measured values; B, calculated mean value without heat dissipation; I, upper edge; II, lower edge.

FIG. 3—HEATING OF WEDGE BAR IN A STATIONARY ROTOR

Ignoring the heat conducted away for a given heat on starting, the temperature of the rotor can only be influenced by increasing the rotor weight. In the case of the double cage rotor, the weight and hence the thermal capacity of the rotor winding are increased by employing materials of low conductivity. In the case of the deep bar rotor and wedge bar rotor, owing to the accompanying reduction in the skin effect, this is not as a rule possible, and the obvious method is to make use of the core for increasing the thermal capacity of the rotor winding. But, owing to the clearance necessary for assembling deep bars, it is not possible to rely upon a uniform heat transfer, and this method can only be utilised to a comparatively slight extent. With the wedge bar rotor, on the other hand, clearance or play between the bars and iron can be eliminated by the method of wedging. The uniform heat transfer is assisted by the large area of contact and by the higher specific heat of the iron. These considerations have been confirmed by measurements made by thermo-couples on a wedge bar of a large motor. The temperature values obtained at 55 per cent. of the rated voltage with the motor stationary are shown in Fig. 3. The curves A represent measured temperatures and the curve B the temperature calculated without allowing for the heat transmission. The low temperature difference between the upper and lower edges of the bar is striking; also the considerable difference between the measured and calculated temperatures, ignoring heat transmission. As the measured values are considerably lower than those calculated, a considerable portion of the heat of the copper must be absorbed by the iron. Hence it may be expected that the thermal capacity of the bars will be increased approximately three or four times by the rotor iron. Owing to the tapered construction, the thermal strain at starting is considerably reduced, and the reliability and life of the squirrel cage rotor are favourably influenced.

Where, in consequence of special working conditions, the demand for reliable operation is increased, the tapered bar rotor is claimed to be in all cases advantageous. It is particularly suitable for high-speed motors in which, in view of the high peripheral speeds and large conductor cross sections, the rotors are subjected to high mechanical stresses. The wedge bar rotor is also recommended for motors used where there is danger of explosion, and in all cases where motors are frequently started and stopped.



GENERAL ARRANGEMENT OF MARINE STEAM TURBINE

2500 S.H.P. Geared Steam Turbine Unit for Marine Propulsion

In the accompanying drawing we reproduce a general arrangement of a new type of geared steam turbine unit for marine propulsion, which has been built to the designs of the Macleod Steam Turbine Company, Ltd., of 141, Bath Street, Glasgow, and recently underwent successful steam trials at the works of Belliss and Morcom, Ltd., Birmingham. The principal particulars of the turbine unit are as follows:—

Total designed output	2500 S.H.P.
Number of ahead turbines: Four, one H.P., one I.P., and two L.P.	
Number of astern turbines	Two
Output of astern turbines: 60 per cent. of ahead turbines	
Speed of H.P. and L.P. turbines	10,000 r.p.m.
Speed of L.P. turbines	8750 r.p.m.
Speed of propeller shaft	100 r.p.m.
Speed of astern turbines	7500 r.p.m.
Steam pressure	250 lb./sq. in.
Temperature of superheated steam...	700 deg. Fah.
Full power steam consumption	9 lb. per S.H.P. hr.

The Macleod geared steam turbine unit has been produced in order to meet the demand for a high-efficiency propelling unit, of light weight and small dimensions, for naval and mercantile ships of moderate tonnage. It has been built to the survey of the British Corporation Register of Shipping and Aircraft to a specification exceeding the requirements of the British Admiralty. The geared turbine unit, as will be seen from our engraving, consists of one high-pressure turbine, which exhausts into an intermediate-pressure turbine arranged on the same pinion shaft. From the intermediate-pressure turbine the steam passes to the port and starboard low-pressure turbines, which are arranged on the after ends of the pinion shafts, whose forward ends carry the two high-pressure astern turbines. The two low-pressure turbines, also the two astern turbines, exhaust directly into the condenser at the back of the unit, suitable expansion pieces being provided in the connecting piping. The power from the three pinion shafts is taken through double-reduction single helical gearing to the propeller shaft, which has a designed speed of 100 r.p.m. The axial thrust of the gear teeth is balanced by the action of the steam on the ends of the turbine shafts, which in turn is transmitted through the gearing to the propeller shaft, resulting in the propeller thrust being substantially reduced. The six turbines are all mounted over the top of the gear casing, an arrangement which, it is claimed, allows of maximum accessibility and general ease for inspection and overhaul. Inspection doors for the gearcase are provided, and an arrangement of forced lubrication for the turbine and gearing bearings is incorporated in the design, complete with main and auxiliary oil pumps, of which the former is reversible and is driven from the main propeller shaft. The control valves are arranged at the front of the high-pressure ahead turbine, a simple arrangement being adopted whereby one hand wheel controls the ahead valves and the full-speed astern valves. During the recent trials the time from full-speed ahead to full-speed astern was only ten seconds, the change in the opposite direction being carried out in the same time. The control valves are grouped in the high-speed ahead turbine casing, along with the main governor valve, which is oil operated from the governor gear arranged on the main oil pump shaft. The steam turbines condenser and accessories were built to the order of the Macleod Steam Turbine Company, Ltd., by Belliss and Morcom, Ltd., Birmingham, and the gear casings, which are of welded mild steel, and the single helical double-reduction gearing by David Brown and Sons (Huddersfield), Ltd., of Lockwood Works, Huddersfield, all the parts being made to the designs and under the supervision of the owners. The complete unit comprises an electrically driven turning gear and a forced lubrication system, including oil pumps, strainer, and cooler, with the necessary interconnecting piping. The complete weight of the unit, which in this case incorporates the thrust block and the condenser, is about 28 tons. The designers claim that this weight must be compared with one of about 153 tons for a triple-expansion marine engine of equal power, the total heights being 24ft. and 15ft. and the engine-room lengths 32ft. and 18ft. respectively. The amount of fuel used is stated to be 30 per cent. less than when working with a reciprocating steam engine. A steam consumption of 8·4 lb. per S.H.P. per hour has been obtained under test at full load at the makers' works. We are given to understand that it is intended to run other tests, and at a later date we hope to give further particulars of this propelling unit and its performance.

BRITISH FOUNDRY SCHOOL ANNUAL VISIT.—The annual visit of the British Foundry School to another foundry centre was held this year in Sweden, and during a period of seven working days ten plants were visited, embodying every type of foundry, grey and malleable cast iron, steel and non-ferrous metals. Some foundries were semi-mechanised and others fully mechanised, while two of the plants were equipped for the vitreous enamelling of both steel and cast iron. The new session of the School will open on September 19th next, and applications for admission can now be made.

Transport Conditions in Great Britain*

By C. E. R. SHERRINGTON, M.C., M.A., M. Inst. T.,
(Secretary, Railway Research Service).

IN order to comprehend the existing situation in Great Britain, it is necessary to have some knowledge of the historical background. Yet to give that scene in true perspective would require a whole paper and permit of no time for a survey of the present.

Hence my historical outline will not retrace past history beyond 1923, when most of the provisions of the Railways Act of 1921 came into effect; for instance, the amalgamation, with but few exceptions, and these local and exceptional in character, of the British railways into four large groups.

Those interested in that Act will find an economic analysis in the *American Economic Review* of June, 1924, whilst a masterly survey outlining the "State Control of Transport Services and Rates in Great Britain," penned by Commissioner Clyde B. Aitchison, will be found in the recently issued volume entitled "Ownership and Regulation of Public Utilities," of the Annals of the American Academy of Political and Social Science.

The British "Railways Act, 1921," corresponded to the "Transportation Act, 1920," and, coming shortly after it, bears several close resemblances to it.

For example, it placed in separate hands control of charges in Great Britain through the setting up of the Railway Rates Tribunal and the control of the largest item of expenditure, namely, wages, through the formation of the Central and National Wages Boards, changed in 1935 to the Railway Staff National Council and the Railways Staff Tribunal, when various alterations were made to the negotiating machinery. The British problem was simpler than the American, owing to the existence of clear-cut and well-established railway trades unions, whose representation on the Wages Boards was duly laid down in the Act itself.

The policies provided for by the Act of 1921 were an alternative to the nationalisation of the railway system, which had been in Government control during the war period, and clearly assumed that negotiations between the railways and their employees should be carried out through the agency of three important trades unions.

Here one finds one major difference between the British and American positions at that time.

On the whole, it can be claimed that, with the later adjustments which have since been made, the labour provisions of the 1921 Act have worked reasonably well. It is true that the General Strike of 1926 brought the railwaymen out, but the origin of the trouble lay, not in the railway industry, but in the coal industry, and the causes of the strike were, to a large extent, political rather than industrial. This same Railways Act of 1921, which remains the modern charter of the British railways, though it is likely to be materially altered in the near future, changed the freight classification completely and provided for twenty-one classes and a coal class; it also set up a new structure of standard charges, which came into force on the "Appointed Day," namely, January 1st, 1928.

The aim in the design of so many classes was to eliminate as many as possible of the so-called exceptional rates which had grown up over a long period of years, many of these being due to coastwise and water competition. In this connection it should be mentioned that there is no important industrial centre anywhere in Great Britain more than approximately 65 miles from navigable water.

The intent is to be lauded, but the results were completely unsuccessful, mainly due to the rise of highway competition, which has steadily extended ever since the termination of the war. It will always be a mystery why those responsible for the Act, who had so much experience with the value of road transport in the war areas, should have so completely failed to envisage its inevitable rise after the war period.

RAIL AND ROAD

Too often uninformed opinion in Great Britain is still critical of the railways for not forestalling the rise of the motor vehicle. The charge is completely invalid. British railways from their earliest origin have realised the value of rail and road co-operation. Indeed, a great road operator, Chaplin, became chairman of one of the big main lines, the London and South-Western Railway, in 1839, and Pickfords, the famous road and water carriers, were early linked with rail transport.

Chaplin's partner, Benjamin Horne, might almost have been termed goods manager of the London and North-Western Railway, and his brother Henry was still in charge of the parcels work of the firm when it was taken over by the railway in 1874. During the last few years the four railways jointly have taken over the road haulage firms of Pickfords and Carter Paterson, and even prior to motor days the co-ordination of these road operators with the railways was at times very close.

It was a British railway that laid claim to the operation of the first motor bus route in a country district in 1903, that is, over thirty-five years ago. To-day, the British railways have over 50 million dollars invested in so-called associated bus-operating concerns, and over 12 million dollars in road freight concerns, chiefly accounted for by Carter Paterson and Pickfords.

It is of interest that the bus investments are probably the most remunerative of any branch of British railway activity. Though the shares in many cases had to be acquired at a premium, the return on investment averaged 11 to 14 per cent. for 1938.

In addition, the railways own their own large fleets of road freight vehicles primarily, but not wholly, engaged on collection and delivery services. For the four railways together these vehicles totalled 10,367 motor trucks or mechanical horses and 24,823 horse carts, the latter for short-distance town collection and deliveries.

It was, however, only in 1928 that powers were obtained by the railways to carry throughout by road, and to obtain financial interests in road transport (other than collection and delivery), and these powers were obtained after a long-drawn-out legal battle. The delay was not due to railway inability to foresee the advantages of rail and road co-ordination, because road powers had been refused the railways. Prior to the enactment of the Railways Act, 1921, a Government Committee inquired into the matter and by a majority representative of trade, industry, motor transport, and labour such powers were not recommended.

Again, in 1922, the railway companies sought by private Bill legislation to obtain powers, but the Bill had to be withdrawn owing to strong opposition.

Sufficient has been said to demonstrate that the British railways have never failed to regard themselves as transport providers in the widest sense; since the early days they have been linked to road transport and have owned large numbers of road vehicles, at that time horse-drawn.

At early dates they became dock owners and collectively own the largest system of docks in the world. Southampton, so well known to American citizens, owes its prosperity and vitality to the Southern Railway; Cardiff, Newport, Swansea, and other ports were really the parents of many of the South Wales local coal railways, and are all now in Great Western Railway ownership; Hull, the largest port on the East Coast (other than London) is owned by the London and North-Eastern Railway; the London, Midland and Scottish Railway possesses Fleetwood, a great fish-landing centre, Garston, Grangemouth, and other ports.

The British railways also own a magnificent fleet of fast short sea mail and passenger and cargo vessels, whose services range from Hamburg and Havre to Belfast and Rosslare.

To assist their traffics the railways have developed a great hotel ownership, seventy in all, which service links in well with the catering required on diners and at station restaurants and buffets.

Their latest endeavours have been to build up an internal air network, but the climatic and geographical conditions in so small a country do not lend themselves well to the operation of remunerative air services without the grant of subsidies. Such is the background of the British railways as transport concerns, and few will be found who would maintain that in each of these varied spheres the railway-owned service is not the equal, if not the superior, of any comparable service offered, whether by sea, harbour, road, or air, or even in regard to hotel management and catering.

RAILWAY CONSOLIDATION

The aim of this paper is to give you a *resumé* of modern and, indeed, existing conditions, and they mainly fall under two categories, further consolidation, with which is closely allied the question of State ownership and control by a public board and the problem of charges.

Both of these tie back to the provisions of the 1921 Act. That Act brought all but a few local lines (largely consisting of the electric rapid transit systems in London and Liverpool) and certain railways jointly owned by two of the large grouped railways within four large railway systems. When I say large, I mean large for Great Britain, for they are still small as regards route mileage compared with such wide-flung systems as the Pennsylvania, the New York Central, the Southern System, the Southern Pacific, the Rock Island, or the Milwaukee.

On the other hand, the capital investment per road mile is heavy, being about 250,000 dollars, the track mileage, inclusive of sidings, is more than double the mileage of road, and there are approximately one locomotive, two passenger cars, and thirty-one freight wagons per mile of road.

Yet from the organisation view-point, areas are small; in fact, the whole country has an area not very different from that of New York State, and from London to the northernmost part of Scotland is under 750 miles.

The problem of the few jointly owned lines took some years to solve, but as a general principle, with one exception, they are no longer treated as separate railways, the operating work being placed in the hands of one parent company and the track and rolling stock maintenance in the hands of another. Separate accounts have, of course, still to be kept, in order that the appropriate amounts may be debited or credited to the parent companies.

Exclusive of the electrified passenger lines of the London Passenger Transport Board and the two electric passenger lines in the Liverpool area, the remaining small independent railways outside the four large railways total but 200 miles, and are purely local or industrial in nature. Indeed, few countries could claim to have brought their railway mileage within such a small number of ownerships.

A fascinating account of the consolidation and other policies of the 1921 Act was written by the late Howard C. Kidd, one of the most penetrating students of transportation economics. Entitled "A New Era for British Railways," its lucid 150 pages will well repay the study of those interested in consolidation hopes, fears, and results.

The British consolidation has been quoted frequently of late, in view of similar proposals in respect of American railways, but it is doubtful if the comparison between the position in the two countries has not been over-stressed, and the comparative sizes of the areas concerned are too often forgotten.

Many of the railways combined in 1923 were end-to-end amalgamations, thus permitting lengthier locomotive runs and better design of rolling stock rosters.

Whilst no one can, or ever will be able to assess the financial savings of the amalgamation provisions for the simple reason that conditions have not remained *coeteris paribus*, it can be definitely stated that but for the adoption of this policy many of the smaller lines must inevitably have gone under financially. No one would ever think of going back to the pre-war organisation with 123, mostly very small, independent railways.

It is true that expenditure on railway working for the four railways fell from about £157 million in 1923 to approximately £117 million in 1933, but changes in the price level, reduction in traffic, and other financial considerations played a very important part in this decrease of approximately 25 per cent.

The year 1923 was the best post-war year financially and may be compared with 1926 or 1929 in the United States.

It is of interest to contrast the fall in expenditure on the Class I railways between the peak and the minimum year, namely, 1926, when the operating expenditure was about 4670 million dollars, and 1933 when it was but 2250 million dollars, a fall of 52 per cent.

One aspect of the British consolidation requires some comment. It is often stated, even by experts, that the British railway amalgamations of 1921–23 eliminated competition; in short, that it was regional in character, following along the lines by which the great French systems grew up. Nothing could be further from the truth, because, as finally planned, most of the great railway trade routes of the country after amalgamation were and still are served by competitive lines.

RECENT LEGISLATION AND ITS EFFECTS

Mention has been made of the powers obtained in 1928, namely, the Railway Road Transport Acts, but conspicuous progress could not be achieved until the passage of the Road Traffic Act of 1930, which contained provisions for the licensing of all public passenger services by road. Area licensing authorities were established and, by means of the stabilisation thus attained and through the agency of railway financial interests in the various bus-operating concerns, themselves already financially grouped together, a very welcome measure of rail and road co-ordination has been obtained over the period 1929–38.

Unfortunately, the ownership of freight highway vehicles was too diverse to permit of the adoption of a similar policy, though the Road and Rail Traffic Act of 1933 aimed at achieving somewhat similar results.

Approximate figures for 1938 show that the number of private trucks in Great Britain totalled nearly 375,000, whereas public trucks amounted to nearly 140,000. The former, in accordance with the 1933 Act, must obtain a "C" licence, but beyond questions of safety and loading there is virtually no restriction on the grant of such a licence by the area licensing authority. The public carrier has to obtain an "A" licence, he must show a need for the service, and he cannot increase his vehicle tonnage owned without permission, in contrast to the provisions of the corresponding American Act. On the other hand, he is in no wise controlled in regard to the charges he may make, and there is nothing to prevent him cutting rates to a very low level.

The "B" licence holder is the "limited carrier," who may carry his own goods and those of a third party, but his area of operation may be restricted.

It was realised that conditions of service in the road transport industry were far from satisfactory, and in 1938 an Act was passed setting up a Central Board to regulate wages and conditions of service of the men travelling on road vehicles. This recent legislation should do something to correct the advantages hitherto enjoyed by the irresponsible road operator *vis-à-vis* his more responsible road competitors, and, of course, the railways.

* Association of American Railroads, Finance, Accounting, Taxation and Valuation Department. Accounting Division Annual Meeting in Toronto, June 28th, 1939.

A feature of the Road and Rail Traffic Act, 1933, was the permission it granted to the railways to quote "Agreed Charges" with individual traders. The scheme has met with conspicuous success, and has been emulated in Canada and in France, but there is some misapprehension abroad as to the effect of the system, and I would take this opportunity of stressing the fact that, with one or two exceptions, there has been no opposition from shippers in Great Britain to the system or its method. Indeed, it is always understood that the shipping interests were the early protagonists of a trial being given to the plan. The main exception was the unique case of the Woolworth Company, where the "Agreed Charge" consists of a percentage (now 3·95 per cent.) of the firm's annual turnover. Of course, this, like other "Agreed Charges," is reviewed annually, and there has been no opposition since the first year.

So successful have "Agreed Charges" proved that 824 were in operation in June, 1939, from which receipts of 21 million dollars are derived. Each "Agreed Charge" must be publicly advertised and considered in public by the Railway Rates Tribunal before it becomes legal.

There is no truth in the suggestion that it benefits the large shipper, or that it acts as a reduction in rates; indeed, the "Agreed Charge" is based on the average of rates he has paid in the past; but the savings accrue through large-scale reductions of clerical work, not only to the shipper, but to the railway, and it has the satisfactory aspect of tying a firm's traffic to the rails, except for those sections of it which can best be handled by alternative means.

The new system regulating rates and charges as provided for in the 1921 Act was introduced on January 1st, 1928; standard charges for each of the amalgamated companies being fixed by the Railway Rates Tribunal for all classes of freight at a level which, with efficient and economical working and management, was to yield, taken in conjunction with other sources of revenue, the so-called "Standard Revenue." This latter was defined as an annual net revenue equivalent to the aggregate net revenues for 1913, together with allowances for capital expenditure not fully fructified at that time or expended on the properties in subsequent years.

Thus, year by year, the standard revenue for each of the four railways tends to rise, but in no year since 1928 has the standard revenue in any one year actually been attained by any of the companies.

The Tribunal reviews the charges at annual intervals but the onslaught of trade depression and the loss of monopoly characteristics due to the rise of road competition has made the railways hesitant in claiming any general rise in freight rates or passenger fares, and, indeed, there has been but one general increase amounting to approximately 5 per cent., which came into force in October, 1937. Passenger fares in the London area were excluded from this general rise, but have since been brought into line as from June 11th, 1939, with the rest of the country.

It is significant that, in its judgment in respect of this latest charges case, as indeed in each annual review, the Railway Rates Tribunal pointed out that there was nothing to suggest, and it was not suggested, that there had been lack of economy in the management of the companies. Further, it stressed the point that reductions of expenditure to secure additional net revenue cannot be made without detriment to existing services.

Perhaps most important of all was the declaration that the net revenues of three of the railway companies were not adequate, having regard to their responsibilities and their duties and importance to the public at large, and that the fall in net revenue shown between 1937 and 1938, if not checked, is likely to imperil the efficient performance of such duties.

It is hardly necessary to recall in this instance the fact that the United States and Great Britain provide almost the only examples left in the world of highly industrialised countries relying for their railway network on company-owned and operated systems. Their inability to rely on Government subsidies has been largely responsible for the fact that they stand in the forefront of the world's most efficient railway systems.

The American rate of return on property investment, which has been hardly satisfactory for the Class I railways, as a whole, for many years, is paralleled by the British net percentage of capital receipts. For 1923 this latter figure was 4·40 per cent.; it dropped to 2·64 per cent. in 1932, achieved 3·47 per cent. in 1937, but stood only at 2·65 per cent. in 1938.

In view of the responsibilities now carried by the railway system of any European country, and to ensure that it can function at maximum capacity and efficiency in times of emergency, it is essential that it be kept fully modernised and that modernisation, in the case of company-owned railways, can only be assured by the ability to raise new capital for betterments and to allow of the most economical methods of working being attained.

There are many examples of the savings in operating expenditure due to resignalling and other forms of improvement requiring capital on all railways, whether in the United States, Canada, or Britain.

The disastrous fall in freight traffic receipts during certain months of 1938, almost unique in British railway history, provided the final urge which led to the British managements launching their campaign in favour of a "Square Deal," and addressing a request to the Minister of Transport for relief from outworn legislative restrictions, dating from days of monopoly, but now strangling the railways' ability to clothe themselves with the latest commercial methods, a hindrance which applied almost alone to them amongst industries.

The "Square Deal"

The Minister of Transport, in response to this request, referred the matter for urgent report to the Transport Advisory Council, a body set up under the Road and Rail Traffic Act, 1933, and consisting of representatives of local authorities, railways, users of mechanically propelled and horse-drawn vehicles, pedestrians, canals, pedal cyclists, coastwise shipping, harbours and docks, labour and trading interests. In his covering letter the Minister stated that he was inclined to the view that in existing circumstances there was, *prima facie*, a case for some material relaxation of existing statutory regulations, provided that due regard be had to the ultimate objective of co-ordination of all forms of transport.

The Transport Advisory Council submitted the question to a committee, and this committee met on fifteen occasions.

On April 4th, 1939, the report of the committee was considered and adopted by the Transport Advisory Council, and forwarded to the Minister of Transport. Delayed in printing by congestion of official publications in respect of defence matters at H.M. Stationery Office, the report only became available in the middle of May.

On May 24th the new Minister of Transport announced in the House of Commons that the Government had decided to accept in principle the recommendations of the Transport Advisory Council on the proposals of the main line railways, and that appropriate legislation would be introduced as soon as possible next session.

It remains for me to summarise shortly the recommendations of the Transport Advisory Council which have been thus accepted by H.M. Government. The result is highly satisfactory, though tempered by the disappointment that, owing to preoccupation with international affairs, it has proved impossible to obtain remedial legislation during the present session of Parliament.

Even so, if good progress is made later in the year the whole stage from original request to the grant of the Royal Assent will have taken but little over twelve months, in reality but a short period of time for the completion of such a revolutionary and evolutionary legislative landmark.

The Council drew attention to the large measure of agreement which had been reached in the course of the negotiations between the railways and the trading and industrial interests as to the relaxations from legislation and the measures to be taken for the protection of trade and industry. In general, these provided for the setting up of conferences to consider proposals by the railways for any general increase of existing charges, and failing agreement the reference of the matter to a tribunal for determination.

Any increases in individual charges would give a shipper the right to have the matter discussed by the appropriate conference and taken, if necessary, to the tribunal, before which an individual shipper or body of shippers could appear and apply for reduced charges.

The basis of the tribunal's judgment is to rest on the reasonableness of the proposed charge, and certain guiding lines are laid down as to reasonableness—for instance, whether or not it is detrimental to the public interest, variations in the value of currency, cost of affording the service or services for which the charge is made, existence of alternative or competitive transport facilities and the charges made by these, effect of the charge on the financial position of the parties concerned, either in general or individually, and, finally, the charge made to other shippers for the carriage of like freight if it affects the shipper concerned.

Whilst regret is expressed that the railways had been unable to reach agreement with the coal industry, the Council regards the agreement reached with the other interests as a suitable basis for the determination of railway freight charges during an interim period not to exceed five years, and therefore it recommends that effect should be given to them, while noting that the railways do not propose alterations in regard to the statutory provisions in respect of the obligation to provide reasonable facilities, to continue provisions as to through rates and standard conditions of carriage.

Since it was not possible to reach agreement on the important question of the publication of rates, no recommendation is made by the Transport Advisory Council on this matter, but the railway view is that they will accept any obligation in regard to publication of rates which is made applicable to all forms of transport. In any case, they propose to make their charges known on appropriate commercial lines to all interested parties.

Repeal is recommended by the Council in respect of the classification of freight and the standard charges, exceptional rates, and agreed charges, and the obligation of the Railway Rates Tribunal so to adjust charges as to ensure a standard revenue, a safeguard which has been largely a dead letter.

Finally, the existing statutory provisions in respect of equality of charge and undue preference are recommended for repeal. It will be realised at once that these recommendations open up an entirely new vista of railway endeavour, at any rate so far as concerns charging powers on freight traffic, and they are of peculiar interest and importance in the United States at this time, when so much attention is being given to the question of the rate-making clause.

Analogies should not, however, be drawn too closely. The areas of the two countries are different in extremes and what may be suitable for a small, densely populated country may be utterly unsuitable for a country of wide areas and long hauls, with all the problems that it brings of market competition.

Conclusion

No one conversant with the British transport position would claim that Britain has solved the problem; he could only claim that energetic action has been taken to meet the problem along lines which have been limited to the narrow boundaries permitted by existing and periodically built-up legislation, each decade having added bricks or layers of bricks to the regulatory edifice.

The development of container working, the system of "agreed charges," the co-ordination of rail and bus services, not to mention the steady acceleration of train services, in some instances leading to ultra high-speed running, and other practices, have met with very considerable success.

But there were limits to initiative, limits set by the walls of rigid Government control and regulation, a reminder of the nineteenth century when railways enjoyed virtually monopolistic powers, so far as inland transport was concerned. It was to sweep away some of these outworn restrictions that the railways launched their "Square Deal" campaign, and it would seem that, if the promised legislation is duly passed without serious amendment, a new era will be opened up for the railways. A new era in which, revivified and commercialised, they will, as private companies, be able to play an increasingly important part in the national economy, and yet with some better degree of profitability for those whose savings made their construction possible.

Technical Reports

Profile and Skin Friction Aerofoil Drags. By A. Fage, A.R.C.S. Air Ministry Reports and Memoranda No. 1852.—The purpose of the inquiry was to compare distributions of skin friction calculated by the method of Squire and Young (R. and M., 1838) for a large symmetrical Joukowski aerofoil, thickness ratio 0·15, with distributions measured with surface tubes and with those deduced from velocity measurements in the boundary layer (R. and M., 1315). To show the dependence of the calculated skin friction drag on the position taken for the transition from laminar to turbulent flow in the boundary layer. To point out the importance of the pressure term in the Squire and Young formula, derived for the calculation of profile drag from traverses of total pressure and static pressure taken close behind the trailing edge of an aerofoil.

Range of Investigation.—Calculations of skin friction drag were made for pressure distributions measured in a wind tunnel on the Joukowski aerofoil at an incidence of $-0·18$ deg. and two Reynolds numbers, $U_0C/\nu = 1·248\times10^6$ and $1·665\times10^6$, and for transition points taken at the beginning and within the observed transition regions. Experimental values of skin friction drag were determined (*a*) by subtracting the form drag, deduced from the measured normal pressure distribution, from the profile drag, measured by the pitot traverse method, and (*b*) from velocity observations and the integral momentum relation of the boundary layer.

Conclusions.—For laminar flow in the boundary layer, the calculated curves of skin friction and the curves deduced from the momentum relation lie below (except at the leading edge) the surface tube observations. For fully turbulent flow, the calculated curves follow the general trend of the observations. In the transition region, the calculated curves depart appreciably from the observations, and this departure arises from the wide extent of the observed transition region and from the assumption of an abrupt transition. The transitions observed in the tunnel were much less abrupt than those commonly observed in flight.

The discrepancy between the calculated and measured skin friction drags depends appreciably on the position of the point of abrupt transition taken in the calculations. For a transition point taken at the beginning of the observed transition region, the calculated skin friction drag exceeds the measured value by 18 per cent. at $U_0C/\nu = 1·248\times10^6$ and by 13 per cent. at $U_0C/\nu = 1·665\times10^6$; but close agreement is obtained when the transition point is taken near the middle of the observed transition region.

Calculations made for an aerofoil tested at Cambridge show that the profile drag given by the Squire-Young formula, which takes into account the static pressure gradient in the wake, for observations of total pressure and static pressure in the wake close behind the aerofoil, is in close agreement with the value given by the Jones formula.

Qualitative Experiments on "Reed Oscillation" of Elevators. By W. J. Duncan, D.Sc., A.M.I. Mech. E., F.R.Ae.S., and W. Barnard, M.C., M.Eng., A.F.R.Ae.S. Air Ministry Reports and Memoranda No. 1856.—Model tests are described which indicate that in certain conditions an elevator may execute self-excited flexural oscillations.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The International Steel Markets

There has not been any material change in the situation in the Continental iron and steel markets. Belgian makers report that their order books are comparatively well filled, and as the German and French producers are concentrating mainly on their huge home demand, the bulk of the export business passing is coming to Belgium. It is anticipated that the July bookings of Cosibel—the Belgian works' selling organisation—will reach close on 200,000 tons, the level attained in June. British buyers have been specifying very heavily for semis, and India and Japan have also been good buyers. Business in plates with Northern Europe is quite good, but the trade in merchant bars is not so active as had been hoped for. Recent rail orders received by the International Rail Cartel total 40,000 tons for Iran, of which Polish mills have been given 12,000 tons. As a result of recent negotiations a Comptoir for the sale of phosphoric and semi-phosphoric pig iron has been formed, and export prices have been fixed. Producers in France, Belgium, Luxemburg, and Holland are in the new Cartel. In France the home demand for steel is such that works will be fully occupied throughout the rest of the summer, and in some cases deliveries are from seven to eight weeks overdue. The German production of iron and steel continues at a high rate, and for pig iron for the six months ending June 30th amounted to close on 10 million tons. Most, if not all of the production of iron and steel is being consumed in the domestic markets. From Turkey it is learned that the Karabuk iron and steel works planned to open in August may not be able to work to capacity after all, as there is a shortage of wagons to carry the coal the necessary 60 miles in one direction, and to carry the ore some 400 miles in the opposite direction. There is also great difficulty in obtaining scrap in Turkey, and plans are being considered to salvage vessels lying wrecked along the Turkish Coast. From America come reports of better working conditions and mill operations are now at the highest of the year, and expected to go still better this month when motor car manufacturers will probably release more specifications. Prices generally are firmer.

The Pig Iron Market

Little change has occurred in the position of the pig iron market. The production of basic iron is still on a large scale, but nevertheless there is none available for the open market. The demand for hematite has made steady progress since the price was reduced a month ago, the bulk of which is, naturally, on home account. Foundry pig iron remains a dull market, and makers prefer to keep the production within the limits of consumers' requirements rather than increase the output to accumulate stocks. In the latter connection it is interesting to note that suggestions are still being put forward that supplies should be laid up against an emergency, not only now, but at all times. Mr. T. McKenna, General Secretary of the National Union of Blast-furnacemen, recently suggested that employment could be made more secure by producing regularly in times of poor trade, and stocking against a boom or crisis period. Had this been done in recent years, he maintained that instead of only seventy-six furnaces being in blast in 1938, 115 furnaces could have been kept going. On the North-East Coast good sales of hematite are reported. Consumers have made rapid strides in replenishing reserves during the past month, and as the production in July has been below the level of deliveries, stocks have materially diminished. In the Midlands buying has been at the highest rate for many years. Large quantities of basic iron are being turned out, all of which are going direct into consumption. In this area also foundry pig iron is neglected, as the light casting and foundry trades are slack, and concern is expressed at the steady decline in this trade. Quiet conditions prevail in Lancashire as regards new business. Some contracts have been placed for delivery up to the end of the year, but for the most part consumers require early despatch. In the Midlands low-phosphorus pig iron is moving off in fair quantities, but the demand for high-phosphorus grades is quiet, as consumers' order books for goods manufactured from the latter quality are not well filled. Hematite has continued active and makers are hopeful that the demand will be sustained for some time to come. Business in the Scottish pig iron market has been resumed after the holidays, but there is no marked revival in activity. Foundries in general have covered their more urgent requirements and short time continues the rule in the light casting section. In South Wales there is a big demand, especially for hematite, as the steel makers have a large volume of orders on hand. Sheffield reports indicate a marked improvement in the demand for foundry grades, but forge pig iron is still in poor request. The demand for hematite is on a heavy scale, particularly for special qualities, while consumers of basic pig iron are taking up regular quantities. Business on the North-West Coast has eased off so far as forward buying is concerned, and not much change is expected until after the holidays, but deliveries to consumers are continuing on a large scale to the Midlands, Wales, and Scotland.

Scotland and the North

The intense activity prevailing in the steel area in Scotland is indicated by the fact that in one week recently Colvilles Clydebridge works, which operated right through the holidays, turned out a record output of 7090 tons of plates. Most of the other works have now resumed rolling, though some are still engaged on repairs and renewals. Government demands are on a colossal scale, and steel makers are likely to be fully employed for several months to come. Production at the heavy steel departments is at full capacity, and makers are hard pressed to meet delivery dates. Large tonnages of structural steel are being made for armament and defence purposes, and as the sheet makers have contracts extending over many months they are taking little interest in the small export business offering. A good demand is coming from the boilermakers, who have substantial orders on hand, both for the home and overseas markets. Tube makers, also, are busy. Re-rollers are turning out large quantities, but the supply of billets is still inadequate to meet the full requirements of users. Steady progress is being made in the shipbuilding industries, and the recent Admiralty contracts for mine sweepers will ensure continuous activity at the yards, while further contracts are said to be pending. Merchant shipbuilding, also, has made good strides with the result that the steel makers catering for this industry are receiving a steady flow of specifications. The resumption of work at the iron mills and forges has been delayed as the orders accumulated during the holiday stoppage were insufficient to warrant a restart. Most of the restricted demand for wrought iron is for prompt or early delivery, and there is no great interest shown in forward contracting. Bookings of the various classes of steel in the Lancashire district continue at a steady rate despite the fact that consumers have been buying regularly for some time past and deliveries are extended. The locomotive section has been more active, and some good orders for boiler plates have been placed. Tank makers, too, are busy and needing good supplies of raw materials. Sheets and all classes of semis are in keen demand, while the call for steel of special qualities is such that delivery dates on new business extend three to four months ahead. The iron section of the trade is still neglected. A certain amount of business in bar iron has passed, but no important tonnages are involved, and in most cases prompt or early delivery is required. Steel makers on the North-West Coast are busy and likely to be well employed for some time. The holidays are now approaching and at the Workington mills steel rolling has been suspended until the second week in August.

Current Business

The Sankey Works, Warrington, formerly operated by the Liverpool Refrigeration and Engineering Company, Ltd., has formed a close connection with Rubery Owen and Co., Ltd., and the title of the Warrington company becomes Rubery Owen Messier Ltd. The chief product will be Messier aeroplane retractable undercarriages and other Messier hydraulic control systems. At the same time Aviation Engineering (Messier) Company, Ltd., of London, has been amalgamated with Rubery Owen Messier Ltd., and the technical staff sent to Warrington. It is hoped to continue the tube and galvanising departments at full capacity. The Fairfield Shipbuilding and Engineering Company, Ltd., Govan, has received a contract from the L.M.S. Railway for two fast twin-screw turbine steamers for the Holyhead-Kingstown service. The following firms have each received Admiralty contracts for two mine-sweepers in the 1939 programme:—William Hamilton and Co., Ltd., Port-Glasgow (machinery by J. S. White and Co., Ltd.); the Ailsa Shipbuilding Company, Ltd., Troon (machinery by John I. Thornycroft and Co., Ltd.); and Harland and Wolff, Ltd., Govan, Glasgow. The Union-Castle liner "Dunluce Castle" (8131 tons gross) has been bought by Smith and Houston, Ltd., Glasgow, for breaking up. David Brown and Sons (Huddersfield), Ltd., gear makers, of Lockwood, Huddersfield, are considering plans for the extension of the foundry at Penistone, opened in 1936. Owing to the increase in the number of employees which has risen from 40 to about 600, the Penistone U.D.C. proposes to erect another hundred houses. Sanderson and Co. (Textile Engineers), Ltd., Cross Street, Manchester, have been appointed sole distributors to the trade in the North of England by the Myford Engineering Company, Ltd., Beeston, Notts, makers of small lathes. The Department of Overseas Trade announces that the following contracts are open for tender:—Johannesburg City Council: supply and delivery at Orlando Railway Station of 5200ft. of 9in. black piping, spigot and socket, and 40,000ft. of 2in. by 8 S.W.G. galvanised piping, screwed and socketed (Johannesburg, August 12th); South African Railways and Harbours Administration: supply and delivery of 60,000 lb. flat steel, 3½in. by ⅜in.; 80,000 lb., 3½in. by 1in.; 130,000 lb., 3½in. by 1¼in. (Johannesburg, August 24th); supply and delivery of quantities of bar steel (Johannesburg, August 28th); supply and delivery of quantities of steel wire rope (Johannesburg, August 28th); State Electricity Commission of Victoria: supply and delivery of outdoor transformers (Melbourne, September 12th); New Zealand Public Works Department: supply and delivery of overhead travelling crane (Wellington, September 26th); Cape Provincial Administration: supply and delivery of major road plant (Cape Town, August 11th); Lourenço Marques Port and Railway Administration: supply and delivery of twenty light engine-driven railcars (Lourenço Marques, September 8th).

Copper and Tin

Prices in the London standard copper market have continued to move slowly upwards. Sentiment is moderately cheerful and the amount of business passing has tended to expand. There has been more speculative interest displayed, but as the "bulls" are disposed to take their profits fairly quickly this tends to keep prices in check. Consumption in America, Europe, Russia, and the Far East remains excellent, and the statistics for the next few months seem certain to be good. In fact, the world stocks of refined copper should show a regular reduction for some time to come. There has been some buying during the past few days by the British War Office, whilst Japan has again been in the American market. The American domestic price has been further reduced by 12½ points to 10·25c. per pound delivered by some sellers, though others are still asking 10·37½c. It was, of course, clear from the outset that attempts to raise the price were ill-advised, since consumers over there are well booked ahead and are no longer supporting the market. On the international market electro is quoted at about £50 per ton, equivalent to about 10·45c. per pound, both c.i.f. Europe. The actual consumption of copper in the U.S.A. in June amounted to 57,878 short tons, compared with 50,843 tons in May. Domestic sales there in July were a record at well over 180,000 short tons. Copper exports from the U.S.A. during June totalled 31,446 tons and included 2119 tons to France, 3864 tons to Germany, 2756 tons to Italy, 2607 tons to Poland, 3412 tons to England, 4700 tons to French Indo-China, and 9861 tons to Japan. . . . In the London standard tin market the price remains pegged at £230 sellers for cash. There has been no fresh development of interest in the market, and consumption generally is well maintained, as the world's tin-plate industries are busy. In Great Britain there is an increased demand for canned goods in connection with the accumulation of emergency reserves for food. The South Wales tin-plate works are about twice as busy as they were a year ago. In some circles the International Tin Committee is being urged to make regular statements upon the sales from the buffer stock. The July statistics published by Mr. W. H. Gartsen recorded a slight decline in the visible supply from 22,774 tons to 22,654 tons. The "carry-over" in the Straits Settlements, however, rose from 1208 tons to 2167 tons, but at the principal European smelters (exclusive of the British Tin Smelting Company, Ltd.) fell from 4849 tons to 3570 tons. The total supply of tin in sight thus actually recorded a net decline of some 440 tons to 28,391 tons. Supplies of tin during July were higher at 8322 tons, compared with 7630 tons in June, but deliveries, despite an expansion in the United States from 4925 tons to 5275 tons, were lower at 8442 tons, against 8669 tons in June.

Lead and Spelter

The lead market has been fairly firm during the past few days. The home trade demand is quite good and the world's consumption of the metal seems satisfactory. If the statistical position is not quite as good as producers would have us believe, it is unlikely that there are any large stocks which can be dumped on the market to the detriment of prices. Ordinary industrial interest in some directions, naturally, is being curtailed by political uncertainties; but, on the other hand, large tonnages of lead are going into the great armament schemes now in progress. The Far East in particular is an important buyer and is drawing supplies of lead from Empire countries which might otherwise come to London. It looks as though the British building trade will absorb rather less lead over the next year or so than has been the case during the last decade. The stocks in London Metal Exchange official warehouses fell during July from 12,209 tons to 11,691 tons. In the United States market the price has been advanced this week by 10 points to 4·95c. per pound, New York. Chinese buyers are inquiring in America for 4500 tons of refined lead for prompt delivery. . . . Firm conditions have prevailed on the London spelter market and prices have touched the highest level witnessed since the year opened. The consumption of G.O.B. spelter in the United Kingdom is excellent and the high-grade position is also very good. It is reported that the zinc ore market is assuming a more cheerful aspect and this should tend to help the zinc price, since one of the greatest drawbacks in the position for some years past has been the over supplies of ultra-cheap zinc concentrates. In America the domestic quotation has been advanced 10 points to 4·60c. per pound, East St. Louis. There has been rather more speculative interest on the London market, where speculators have possibly been attracted by the cheapness of the metal. Despite the recent increase in the United Kingdom duty, German spelter is coming into this country.

Non-ferrous Metal Average Prices

The London Metal Exchange official average prices for July showed all-round increases. The movement was particularly marked in copper; cash copper was 18s. 4d. up, three months 18s. 1d. up, and settlement 18s. 7d. higher than the June average. Wire bars rose by £1 0s. 10d. and the average for best selected advanced by £1 2s. 8d. As a result of the "pegging" of prompt tin prices during July the average for cash tin showed an increase of £2 5s. 6d., but for three months was only up by 12s. 10d. Settlement, however, rose by £2 6s. 5d. The July lead averages were rather higher than those of June, and for shipment during the current month rose by 3s. 9d., shipment in the third following month being 4s. 1d., and the average mean 4s. higher than the average for June, whilst the average settlement price was 4s. 1d. up. As regards spelter, the averages were also higher in July. For shipment in the current month the price increased by 4s. 3d., for shipment in the third following month by 4s. 3d., and the mean by 4s. 3d. The average settlement price was 4s. 9d. better than in June. The following are the official London Metal Exchange average quotations for July:—

STANDARD COPPER	Cash	£42	18	9 5/16
	3 Months (Mean)	£43	5	1 11/16
	Settlement	£42	19	0¾
ELECTROLYTIC COPPER (Mean)		£49	2	9¼
DITTO DITTO WIRE BARS		£49	8	4
B.S. COPPER (Mean)		£48	16	10½
STANDARD TIN	Cash (Mean)	£229	18	4
	3 Months (Mean)	£224	16	0¼
	Settlement	£229	19	9¼
LEAD	For shipment the current month (Mean)	£14	15	0¾
	For shipment the third following month (Mean)	£14	17	1 5/16
	Mean	£14	16	1 5/16
	Settlement	£14	15	2¾
SPELTER	For shipment the current month (Mean)	£14	4	8¾
	For shipment the third following month (Mean)	£14	8	8¾
	Mean	£14	6	8 5/16
	Settlement	£14	4	10¼

Current Prices for Metals and Fuels

Makers' official home trade price, per ton, delivered buyers' stations. *Joists, Sections, Bars and Plates are subject to a rebate of 15s. to home users purchasing only from Associated British Steelmakers. †Export prices are for Empire Markets; for other Markets British quotations conform to Cartel prices.

PIG IRON.

Foundry home prices, except for Scotland, less rebate of 5/-. (*D/d Teesside Area.*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Hematite Mixed Nos.	5 15 0	—
„ No. 1	5 15 6	5 15 0
Cleveland—		
No. 1	5 2 0	5 2 6
No. 3 G.M.B.	4 19 0	5 0 0
No. 4 Foundry	4 18 0	—
Basic	4 12 6	—
Midlands—		
Staffs— (*Delivered to Black Country Station.*)		
North Staffs Foundry	5 1 0	—
„ „ Forge	4 18 0 to £5 0 0	—
Basic	4 12 6	—
Northampton—		
Foundry No. 3	4 18 6	—
Forge	4 15 6 to £4 17 6	—
Derbyshire—		
No. 3 Foundry	5 1 0	—
Forge	4 18 0 to £5 0 0	—
Scotland—		
Hematite, f.o.t. furnaces	5 15 6	—
No. 1 Foundry, ditto	5 3 0	—
No. 3 Foundry, ditto	5 0 6	—
Basic, d/d	4 12 6	—
N.W. Coast—		
Hematite Mixed Nos.	5 15 6 d/d Glasgow 6 1 0 „ Sheffield 6 7 0 „ Birmingham	

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Lancs and Yorks—		
Crown Bars	12 5 0	—
Best Bars	12 15 0	—
Midlands—		
Crown Bars	12 5 0	—
Marked Bars (Staffs)	15 15 0	—
No. 3 Quality	10 17 6	—
No. 4 Quality	11 7 6	—
Scotland—		
Crown Bars	12 5 0	12 5 0
Best	12 15 0	12 15 0
N.E. Coast—		
Crown Bars	12 5 0	12 5 0
Best Bars	12 15 0	12 15 0
Double Best Bars	13 5 0	13 5 0
Northern Ireland and Free State—		
Crown Bars, f.o.q.	12 17 6	—

STEEL.

	*Home. £ s. d.	†Export. £ s. d.
London and the South—		
Angles	10 10 6	10 0 0
Tees	11 10 6	11 0 0
Joists	10 10 6	10 0 0
Channels	10 15 6	10 5 0
Rounds, 3in. and up	11 10 6	11 0 0
„ under 3in.	11 17 6‡	11 0 0
Flats, under 5in.	11 17 6‡	11 0 0
Plates, ½in. (basis)	10 15 6	10 2 6
„ ⅜in.	11 0 6	10 7 6
„ ½in.	11 5 6	10 12 6
„ ⅝in.	11 10 6	10 17 6
Un. ⅜in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ½in.	11 13 0	11 12 6
North-East Coast—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Plates, ½in. (basis)	10 10 6	10 2 6
„ ⅜in.	10 15 6	10 7 6
„ ½in.	11 0 6	10 12 6
„ ⅝in.	11 5 6	10 17 6
Un. ⅜in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ½in.	11 8 0	11 12 6
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 16 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ½in. (basis)	10 13 0	10 2 6
„ ⅜in.	10 18 0	10 7 6
„ ½in.	11 3 0	10 12 6
„ ⅝in.	11 8 0	10 17 6
Un. ⅜in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ½in.	11 10 6	11 12 6

STEEL (*continued*).

	*Home. £ s. d.	†Export. £ s. d.
Glasgow and District—		
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ½in. (basis)	10 10 6	10 2 6
„ ⅜in.	10 15 6	10 7 6
„ ½in.	11 0 6	10 12 6
„ ⅝in.	11 5 6	10 17 6
Un. ⅜in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6
Boiler Plates, ½in.	11 8 0	11 12 6
South Wales Area—	£ s. d.	£ s. d.
Angles	10 8 0	10 0 0
Tees	11 8 0	11 0 0
Joists	10 8 0	10 0 0
Channels	10 13 0	10 5 0
Rounds, 3in. and up	11 8 0	11 0 0
„ under 3in.	11 15 0‡	11 0 0
Flats, 5in. and under	11 15 0‡	11 0 0
Plates, ½in. (basis)	10 13 0	10 2 6
„ ⅜in.	10 18 0	10 7 6
„ ½in.	11 3 0	10 12 6
„ ⅝in.	11 8 0	10 17 6
Un. ⅜in. to and incl. 6 lb. per sq. ft. (8-G.)	11 12 6	11 12 6

Ireland—f.o.q.—	Belfast. £ s. d.	Rest of Ireland. £ s. d.
Angles	10 13 0	10 15 6
Tees	11 13 0	11 15 6
Joists	10 13 0	10 15 6
Channels	10 18 0	11 0 6
Rounds, 3in. and up	11 13 0	11 15 6
„ under 3in.	12 0 0‡	12 2 6
Plates, ½in. (basis)	10 15 6	10 18 0
„ ⅜in.	11 0 6	11 3 0
„ ½in.	10 5 6	11 8 0
„ ⅝in.	11 12 6	12 10 0
Un. ⅜in. to ½in. incl.	11 12 6	11 12 6

‡ *Rounds and Flats tested quality; untested, 3s. less.*

OTHER STEEL MATERIALS

Sheets.	Home. £ s. d.	Export, f.o.b. £ s. d.
11-G. and 12-G., d/d	13 15 0	11-G. to 14-G. 11 5 0
13-G., d/d	14 2 6	15-G. to 16-G. 11 15 0
14-G. to 20-G., d/d	14 10 0	17-G. to 18-G. 12 0 0
21-G. to 24-G., d/d	14 15 0	19-G. to 20-G. 12 5 0
25-G. and 26-G., d/d	15 10 0	21-G. to 22-G. 12 17 6

South Africa, Rhodesia, Nyasaland, £14; Canada, £14 12s. 6d., f.o.b. basis. Irish Free State, £14 15s., f.o.q., 4-ton lots.

The above home trade sheet prices are for 4-ton lots and over; 2-ton to 4-ton lots, 7s. 6d. per ton extra; and under 2-ton lots to 10-cwt., £2 per ton extra.

Galvanised Corrugated sheets, basis 24-G.—

Home.	£ s. d.
4-ton lots and up	17 5 0
2-ton to 4-ton lots	17 12 6
Under 2 tons	18 17 6

Export: India, £17 15s. c.i.f.; Irish Free State, £17 5s., f.o.q.; General, £15 15s., f.o.b., 24-G. basis.

Tin-plates—
20 by 14 basis, f.o.t., Bristol Channel Ports, 20s. 4½d.
Tin-plate Bars, d/d Welsh Works, £7 5s.

Billets—100-ton lots and over, 35 to 100 tons, 5s. extra; less than 35 tons, 10s. extra.

	£ s. d.
Soft (up to 0·25% C.), untested	7 7 6
„ „ „ tested	7 12 6
Basic (0·33% to 0·41% C.)	7 17 6
„ Medium (0·42% to 0·60% C.)	8 10 0
„ Hard (0·61% to 0·85% C.)	9 0 0
„ „ (0·88% to 0·99% C.)	9 10 0
„ „ (over 0·99% C.)	10 0 0
Rails, Heavy, 500-ton lots, f.o.t.	9 10 0
„ Light, f.o.t.	8 10 0

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	4/5 per lb.	
Ferro-Tungsten	4/4 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	7/6
„ „ 6 p.c. to 8 p.c.	£23 5 0	7/6
„ „ 8 p.c. to 10 p.c.	£23 5 0	7/6
„ „ Max. 2 p.c. carbon	£36 0 0	11/-
„ „ „ 1 p.c. carbon	£38 5 0	11/-
„ „ „ 0·5 p.c. carbon	£41 0 0	12/-
„ „ „ carbon-free	10d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose), 76 p.c.	£16 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- p.u.	
„ „ 75 p.c.	£17 0 0 scale 6/- p.u.	
„ Vanadium	14/- per lb.	
„ Molybdenum	4/10 per lb. 5/- forward	
„ Titanium (carbon-free)	9d. per lb.	
Nickel (per ton)	£185 to £190 per ton	
Cobalt	8/6 to 8/9 per lb.	

NON-FERROUS METALS.

(*Official Prices, August 2nd.*)

Copper—	
Cash	£44 0 0 to £44 1 3
Three Months	£44 5 0 to £44 6 3
Electrolytic	£49 10 0 to £50 10 0
Best Selected Ingots, d/d Birmingham	£50 5 0
Sheets, Hot Rolled	£80 0 0

	Home.	Export.
Tubes, Solid Drawn (basis)	12¾d.	12¾d.
„ Brazed (basis)	12¾d.	12¾d.
Brass—		
Ingots, 70/30, d/d Birmingham	£39 0 0	
	Home.	Export.
Tubes, Solid Drawn 2/1 Alloy	11¼d.	11¼d.
„ Brazed	13¼d.	13¼d.
Tin—		
Cash	£229 17 6 to £230 0 0	
Three Months	£225 0 0 to £225 5 0	
Spelter—		
Cash	£14 10 0 to £14 11 3	
Three Months	£14 13 9 to £14 16 3	
Lead—		
Cash	£15 8 9 to £15 10 0	
Three Months	£15 7 6 to £15 10 0	
Aluminium Ingots (British)	£94 (net)	

FUELS.

SCOTLAND

	Export.
Lanarkshire—	
(f.o.b. Grangemouth)—	
Navigation Unscreened	18/- to 19/-
Hamilton Ell	17/6
Splints	20/-
Ayrshire—	
(f.o.b. Ports)—	
Steam	17/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	18/-
Unscreened Navigation	18/6
Lothians—	
(f.o.b. Leith)—	
Hartley Prime	18/-
Secondary Steam	17/-

ENGLAND

South Yorkshire, Doncaster—	
Steam Hards	19/- to 20/-
Washed Smalls	16/- to 17/-
Northumberland, Newcastle—	
Blyth Best	19/- to 19/6
„ Second	18/- to 18/6
„ Best Small	15/6
Unscreened	17/- to 18/-
Durham—	
Best Gas	19/9
Foundry Coke	26/- to 28/-

SOUTH WALES

Cardiff—	
Steam Coals:	
Best Admiralty Large	23/6 to 24/-
Best Seconds	23/- to 23/6
Best Dry Large	23/- to 23/6
Ordinaries	23/-
Bunker Smalls	16/- to 17/6
Cargo Smalls	15/- to 15/6
Dry Nuts	27/6 to 28/-
Foundry Coke	35/- to 42/6
Furnace Coke	30/- to 33/6
Patent Fuel	25/6
Swansea—	
Anthracite Coals:	
Best Large	36/- to 38/-
Machine-made Cobbles	41/- to 45/6
Nuts	40/- to 45/-
Beans	33/- to 38/6
Peas	26/- to 30/-
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large Ordinary	22/6 to 24/6

FUEL OIL.

Inland consumption: contracts in bulk.

Exclusive of Government tax of 1d. per gallon; and 9d. per gallon on oil for road vehicles.

Ex Ocean Installation—	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4½d.

French Engineering Notes

(From our own Correspondent in Paris)

Production Engineers

THE requirements of armament manufacture and of private industry have introduced new conditions affecting engineers who are expected to undergo a supplementary training to fit themselves for a more complete management and control of mechanical engineering production. There is, firstly, the necessity of developing the faculties of initiative and research in order to make the best use of scientific progress in its application to the work in hand. Then, the work must be executed in a speedy and economical manner, with proper regard to accuracy and quality. The engineer must be capable of carrying the work through from beginning to end. He must, therefore, have a sound theoretical training and workshop experience which will enable him to take the fullest advantage of technical progress and know exactly how to put the work in hand. These qualifications would seem to be normal, but engineers from big schools do not usually possess them. They too often regard the profession as leading to administrative posts, and the mechanical engineering industry fails to attract a sufficient number of really suitable engineers, whose training has been more practical than theoretical. The Minister of National Education has, therefore, the wholehearted support of manufacturers in his decision to create a Centre of Instruction for engineers leaving schools with degrees. He has also the collaboration of the State industrial services and of the Society of French Mechanics, which promises a sympathetic reception of young engineers being trained in the shops. As a beginning, a number of young engineers from the Ecole Polytechnique, the Ecole Centrale, the Arts et Métiers, and other leading schools will be admitted for a first term of four months from September 1st, when they will be taken on as workers by firms in the Paris area whose syndicates are affiliated to the employers' Fédération de la Mécanique. They will be treated in exactly the same way as the men and will receive the same pay. The object of this arrangement is to enable the young engineer to learn how to use his hands and to identify himself with actual mechanical production. It is of equal value in these times of changed social conditions in placing the young engineer on the same level as workers, with whom he associates and understands their points of view, so that he may eventually be the better able to handle them. This raises his value as an agent in smoothing out differences between the men and employers. The second term for those admitted to the Centre of Instruction begins on January 1st and lasts until July 14th, when there will be lectures three hours daily at the Conservatoire des Arts et Métiers by specialists who will bring all their subjects thoroughly up to date. This supplementary instruction will be developed according to the results of the first year's experience.

The Gibraltar Tunnel

A German technical mission is now in Spain to make a survey of the conditions for driving the long-discussed tunnel under the Straits of Gibraltar. The first scheme was submitted in 1868 by a French engineer, Monsieur Laurent de Villedeuil, but nothing further was done until 1908, when the Spanish engineer, Ibanez de Ibero, decided that the idea of constructing the tunnel under the narrowest part of the Straits would have to be abandoned on account of the maximum depth of the sea exceeding 900 m. He selected alternative routes which would allow of the tunnel being driven at a depth of 400 m., either from the Vaqueros Bay, west of Tarifa, to Tangiers, or from the Cape Trafalgar to Punta-Malabata, the distances being respectively 30 and 33 miles. The plan was fully worked out and provided for a central gallery, 3 m. diameter, with transverse galleries for the construction of two tunnels, 5m. diameter, one on each side. On the completion of the work the central gallery would continue to be used for drainage and for service. In 1918 there were conversations with the British and French Governments on the subject of the tunnel, but they were discontinued when troubles arose in Morocco, and Spain fell into a state of financial collapse that prevented her from embarking upon the scheme. Eight years later Lieut.-Colonel Pedro Jenevois revived the scheme in a modified form which had the advantage of being shorter and less costly. There would be two tunnels for single tracks having a length of 18½ miles between Tarifa and Punta-Altares on the opposite coast. Shafts for drainage would be sunk to the 400-m. level of the tunnel at each end. King Alphonso XIII was keenly interested in the scheme, and so was the French Government, and the sinking of the shaft at Punta-Altares seemed to have given a good start to the tunnel when the Monarchy fell and the Republican Government left the tunnel to its fate. Now the Germans have included the tunnel among the great works they hope to carry out in Spain.

Oil Boring

Search for oil has been undertaken on a large scale in France and the colonies, mainly under the direction of the Office National des Combustibles Liquides. The only oil wells being worked in France are those of Pechelbronn in Alsace. Their production counts for very little in the national requirements. Until recently, the only positive results obtained from boring were a rise of oil in a bore in the South of France and a promising supply under fairly high pressure in Morocco, where it was believed an oilfield had been discovered. In both cases, however, the pressure fell rapidly, and while the existence of oil encouraged further boring nothing so far has come of these operations. Recently, an apparently successful bore has been made a few miles to the north of Saint-Gaudens, in the Haute-Garonne, where gas, having the characteristics of oil gas, has been struck at a depth of nearly 5000ft. It is therefore assumed that the territory may offer prospects of oil production on a commercial scale. The State reserves to itself the right to carry out borings over a large triangular area covering parts of the Gers, the Hautes-Pyrenees, and the Haute-Garonne.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

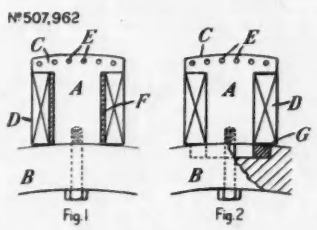
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS

507,962. March 31st, 1938.—SYNCHRONOUS A.C. ELECTRIC MOTORS, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2; and Frederick Albin Youngmark, of Siemens Works, Stafford.

This specification describes a synchronous salient pole type A.C. dynamo-electric machine with a pole face winding for starting it as an induction motor and with one or more short-circuited coils around a pole core or root of a pole for reducing the alternating flux which will link with the ordinary exciting winding around the pole. The laminated salient pole core A mounted on a yoke B and with a laminated shoe C carries an exciting winding D. Part of a polyphase starting winding E is provided on the shoe C. In Fig. 1 a copper sleeve F is placed around and extending along the whole length of the pole from the yoke B to the underside of the pole shoe C. Although from the point of view of effectiveness such a short-circuited coil

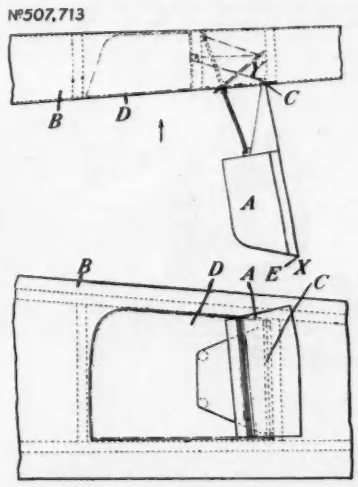


embracing the salient pole core is preferable as it reduces or to a large extent eliminates the alternating flux passing through the core, such an arrangement reduces the depth of winding space available for the exciting winding D. A flat disc G round the root of the pole core A, as shown in Fig. 2, may be less effective, although it reduces the amount of flux linked with the whole of the exciting winding; even this, if bearing on the surface of the yoke, would slightly reduce the length of winding space available and accordingly the disc G is shown as let flush into the yoke B so as to take away nothing from the available winding space. The invention allows of the use of a laminated magnetic circuit throughout, but can be used with a magnetic circuit including a solid portion, although usually in such a case the invention would be unnecessary. The invention can be used with a squirrel-cage type of starting winding, although here again it will usually be unnecessary.—*June 23rd*, 1939.

AERONAUTICS

507,713. July 22nd, 1938.—AIRCRAFT STABILISING FLOAT, Dornier-Werke G.m.b.H., of Friedrichshafen, on Lake Constance, Germany.

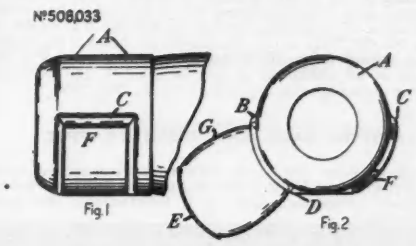
According to this invention, a retractable stabilising float for aircraft is provided wherein the float is of unsymmetrical form and is adapted when retracted to form a complete closure of the opening in a wing when in retracted position. The retractable stabilising float has its axis of rotation in or near the lower skin of the wing, and is of such design that it completely closes up the opening in the lower side of the wing without the necessity of flaps. The retractable stabilising float A is mounted



close to the bottom skin of a wing B and is rotatable around an axis or spindle C. The float is unsymmetrical in form. An opening D is provided in the underside of the wing corresponding exactly to the shape of the float, which is adapted to close completely the opening in the underside of the wing when the float is retracted, thus avoiding the necessity of providing any further flaps. It is an essential feature that the keel E should lie on one side only. The area X Y forming the outer keel plate is shaped in such manner that it completes, when the float is retracted, the underside of the wing and forms an uninterrupted plane. The stabilising float A is shown in its retracted position, in dash and dot lines.—*June 20th*, 1939.

508,033. December 24th, 1937.—FLOTATION GEAR FOR AIRCRAFT, The Bristol Aeroplane Company, Ltd., and Leslie George Frise, both of Filton House, Bristol.

The object of this invention is to provide improved means for enabling aircraft, of the kind which are not intended to take off from or alight upon water in ordinary conditions, to keep afloat when forced down over the sea. The cowling A for an aircraft engine is formed at each side and at the bottom with local streamlined protuberances B, C, D, so as to afford, in effect, two shallow recesses, one on each side of the underpart of the cowl. Each such recess is closed by metal panels E, F, which, as shown on the right-hand side of Fig. 2, normally constitutes a streamlined

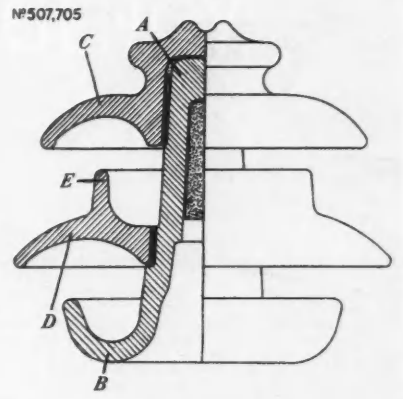


continuation of the protuberances C D and serves as an external part of the cowl. Each panel also constitutes the outermost wall of a flexible air-tight bag, the other walls of which are indicated by G. The bag is capable of being inflated until it assumes the position shown on the left-hand side of Fig. 2 in which it provides substantial buoyancy for the aeroplane should the aeroplane be forced to alight on water.—*June 26th*, 1939.

TRANSMISSION OF POWER

507,705. June 9th, 1938.—PIN TYPE ELECTRIC INSULATORS, Compagnie Generale d'Electro-Ceramique, of 16, Rue de la Baume, Paris.

By this invention the space occupied by pin type insulators with any number of oil baths can be reduced to the minimum. The insulator consists of a petticoat A, the lower overturned part of which forms a receptacle B for oil. To the upper part is cemented a cap C, which forms a protecting cap and carries the high-tension conductor. Midway of the height of the petticoat is secured a cup D forming a second oil bath. This cup is so formed that it provides also a protecting cap for the next lower

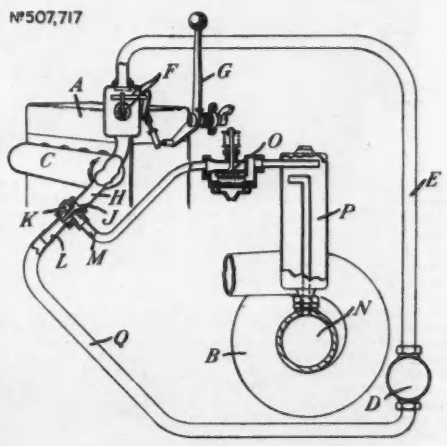


oil bath, constituted by the receptacle D. For this purpose it is turned downwards like the upper cap C and has at a suitable distance from the petticoat A a circular upstanding portion E, which provides the outer wall of a receptacle like the lower receptacle B. The cup D can either be cemented to the petticoat of the insulator or be in one with this petticoat, the parts being either caused to adhere in soft condition, *i.e.*, before baking, or with enamel. The cap C is normally cemented to the upper end of the petticoat. If a cement is used for connecting the cup D and the petticoat the cement is coated with a thick lacquer, which resists the action of the oil; this coating prevents leakage current from passing through the cement.—*June 20th*, 1939.

PUMPING AND BLOWING MACHINERY

507,717. August 15th, 1938.—PRIMING SYSTEMS FOR PUMPS, Coventry Climax Engines, Ltd., and Harold Lunn, both of the Company's address, Friars Road, Coventry, Warwickshire.

This invention relates to priming systems for pumps driven by internal combustion engines, for lifting and delivering liquids, whereby air is quickly extracted from the suction side of the



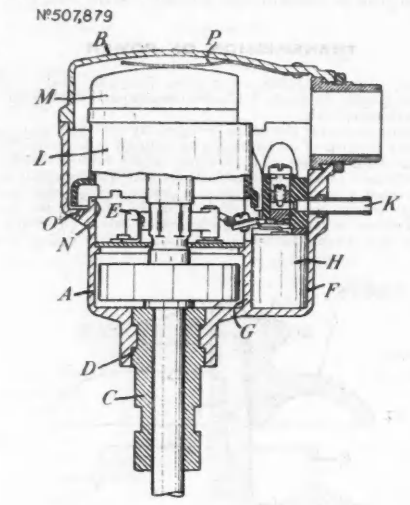
pump and liquid drawn therein so that the pump is rapidly brought into a condition for effectively delivering the liquid. The invention is particularly applicable to pumps of the rotary vane single-stage type which require effective priming before they operate efficiently. The priming system to which the invention relates is of the kind where the pressure of the exhaust gas is used for producing a sub-atmospheric pressure at the

suction side of the pump. The internal combustion engine is indicated at A and the pump which it drives at B. The exhaust manifold C is connected to the exhaust silencer D through the pipe E, which can be closed by the valve F, controlled through the lever G, so as to direct the exhaust gas, during the priming period, through the passage H, terminating in a restricted end J. Round the latter is an annular passage K communicating with a coaxial choke-shaped passage L and laterally with a passage M leading to the suction passage N of the pump, preferably through a valve O and liquid trap P such as are described in the specification of co-pending Patent Application No. 23,984/38 (Serial No. 507,716). A pipe Q connects the outlet of the choke-shaped passage L directly with the silencer. In this way the expense of an additional silencer is avoided, and adequate silencing during priming is provided.—*June 20th*, 1939.

MOTOR CARS AND ROAD TRAFFIC

507,879. October 15th, 1938.—IGNITION DISTRIBUTOR APPARATUS, Robert Bosch G.m.b.H., formerly known as Robert Bosch Aktiengesellschaft, of 4, Militärstrasse, Stuttgart, Germany.

The screening of ignition distributors is effected, according to this invention, in a simple manner by forming the distributor and the screening casing of a single constructional part of metal which is sealed by a cover, also of metal. The casing A and cover B are fastened together by two screws. The distributor shaft C is bedded in the metal casing at the part D. The primary current interruptor E is accommodated in the lower part of the casing. In addition, it contains a pocket F

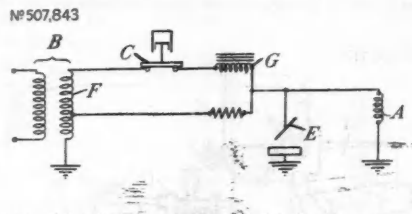


separated from the rest of the casing part by the wall G. The pocket contains the condenser H connected in parallel to the interruptor. The condenser is held fast in its operative position by the retaining plate. The primary current connection is introduced through the sleeve K, which is pressed into the casing wall and caulked therein, and connected with the connection terminal. In the upper part of the casing is the distributor disc, which consists of two parts L and M and which is supported on the rim N and is protected against turning. Ducts O serve for the removal of air from the distributor casing. For holding together the parts L and M and for holding fast the distributor disc there is used a plate spring P.—*June 22nd*, 1939.

WELDING

507,843. December 17th, 1937.—ELECTRIC WELDING, The English Electric Company, Ltd., of Queen's House, 28, Kingsway, London, W.C.2; Albert Thomas Chadwick, Edward John Bertles, and John Stanley White, all of Siemens Works, Stafford.

This invention relates to means for reducing the potential of an electrode holder or equivalent part of electric welding apparatus which is continually in the hands of the operator to a considerably lower value when welding is not actually in progress than that necessary for and used during the actual welding. When the supply is switched on the contactor coil A is momentarily energised by substantially the full secondary voltage of the transformer B and accordingly the contactor contacts C open immediately; the coil, however, remains energised by the lower voltage between the tapping point and earth and the contacts remain open. The electrode E is now disconnected from the



high-potential end of the winding F and is therefore at a comparatively low potential relatively to earth. When the electrode E in the holder is brought into contact with an earthed piece of work for the purpose of striking the welding arc, the contactor coil A is short-circuited and the contactor contacts C accordingly close. The contactor may conveniently be gravity or spring biassed to the closed position. The electrode E is now connected to the high-potential end of the winding F and the full voltage is available for welding. Once, however, the welding current is interrupted the coil A is again energised and the contacts C opened to reduce the potential of the electrode. The contactor is preferably provided with a time lag device. The usual regulating choke coil G for limiting the short-circuit current and stabilising the arc may be connected in the lead from the high-potential side of the winding F and preferably, as shown, between the electrode E and the contacts C.—*June 19th*, 1939.

METALLURGY

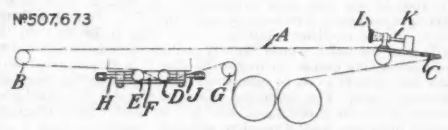
508,541. December 29th, 1937.—REGULATING AND MAINTAINING THE ACTIVITY OF MELT BATHS FOR THE HEAT TREATMENT OF LIGHT METALS AND ALLOYS, Deutsche Gold-und Silber-Scheideanstalt Vormals Roessler, Weissfrauenstrasse 5–11, Frankfurt.a.M., Germany.

This invention relates to the heat treatment, particularly the normalisation, of light metals and alloys, especially aluminium and aluminium alloys, in melt baths which contain alkali nitrates, such as potassium nitrate and sodium nitrate, and/or alkali nitrites, such as potassium nitrite and sodium nitrite. On prolonged use of such baths the bath container or the light metal under treatment or both, for example, become corroded. Research has shown that these disadvantages are due to the formation of alkaline-reacting compounds, such as oxides and carbonates. It was found that even the presence of small quantities, for example, less than 1 per cent., of alkaline compounds in the melt bath may produce detrimental effects. This invention provides a process for regulating and maintaining the activity of alkali nitrite and/or alkali-nitrite containing melt baths, characterised in that the formation or accumulation of disturbing quantities of alkaline compounds is counteracted by the periodic or gradual addition of acid salts, acid-yielding compounds, or other alkali-fixing compounds in quantities sufficient to render the alkaline compounds formed non-detrimental. The following examples serve to illustrate how the process is carried into effect:—In order to replenish the salt melt, *i.e.*, to replace the salt used up, sodium nitrate admixed with 0·05 per cent. of potassium bichromate is employed. It has been found that by this resaturation of the bath with sodium nitrate, potassium bichromate is introduced into the bath in such quantities that in general the desired effect is obtained. If this quantity is not sufficient in any particular case it is, of course, necessary to introduce a higher proportion of potassium bichromate. Such a quantity of a mixture of 90 parts by weight of sodium nitrate and 10 parts of potassim bichromate is daily added to the salt melt, that the alkali formed in the bath is neutralised by the bichromate. The point when sufficient bichromate has been added is easily recognised by the fact that with only a slight excess of bichromate a reddish colour appears. The quantity of salt mixture or bichromate to be added may also be ascertained by titration of the melt. In order to replenish the salt melt, *i.e.*, to replace the salt used up, sodium nitrate admixed with 0·033 per cent. of ammonium metaphosphate is employed. It has been found that by this resaturation of the bath ammonium metaphosphate is introduced in such quantities that in general the desired effect is obtained. If, however, in any particular case it should not be sufficient, it is, of course, necessary to introduce further ammonium metaphosphate.—*June 29th*, 1939.

MISCELLANEOUS

507,673. January 12th, 1938.—BAND OR WEB CONVEYORS, T. and T. Vicars, Ltd., of Earlestown, Newton-le-Willows, Lancashire, and Edward Milner Crosland, of the same address.

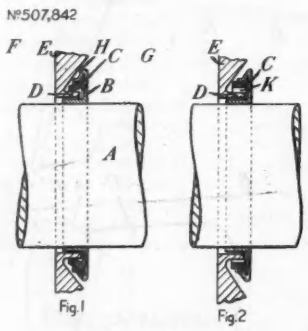
A web conveyor A passing over a roller B and a fixed guide surface C would have the tendency to move out of its predetermined path or run, which is avoided by this invention by passing it over a pair of rollers D E, mounted in a block F. The rollers are disposed so that the conveyor web A is displaced out of its normal run between guide rollers B and G. A block F is arranged on each side of the conveyor web A so that one block can be adjusted in position relatively to the other by means, for



instance, of eyebolts H J provided with milled adjusting heads. Normally, the rollers D E are mounted in bearings in a block F on one side and have swivel bearings in the block on the opposite side of the conveyor web A. Usually, the two rollers are parallel to one another, but, if desired, they may be askew, being arranged at equal positive and negative angles to the normal to the direction of run of the conveyor. The fixed guide surface C may be mounted to be differentially displaceable as regards its ends by means of eyebolts K, provided with milled heads L. By this means it will be seen that the conveyor web A can be tracked at its end and also at a place displaced from this end.—*June 20th*, 1939.

507,842. December 7th, 1937.—SHAFT PACKINGS, Emma Bach, of Aussere Rosenbergstrasse 24, Heilbronn, Germany; and (Dr.) Albert Klein, of Archivstrasse 14, Stuttgart Germany.

The packing described in this specification is particularly applicable to revolving shafts. On the shaft A there is a metal casing B, in which a packing ring C, consisting of resilient material, is gripped. When stationary the ring bears resiliently against an annular packing surface D firmly connected with the frame E of the machine, in such a manner that the passage of fluid from the



inner chamber F to the outer chamber G is prevented. The packing ring C is so arranged that the lip of the packing tends under the influence of centrifugal force to lift from the packing surface D on rotation of the shaft. If the speed of rotation is increased beyond a certain limit there finally occurs a complete lifting of the packing ring C from the annular surface D, as shown in Fig. 2. Owing to the throwing-ring-like construction of the outer rim H of the casing or jacket B, a throwing off of the fluid approaching the packing is effected so that the passage of fluid through the gap K is prevented.—*June 7th*, 1939.

507,983. September 15th, 1938.—HIGH-SPEED TOOL STEELS, Deutsche Edelstahlwerke Aktiengesellschaft, of Gladbacherstrasse 578, Krefeld, Germany.

According to this invention, an alloy suitable for the production of high-speed tools comprises the following components in the proportions stated:—0·7–1·8 per cent. carbon, 2·1–15 per cent. tantalum and/or niobium, 0·3–5 per cent. vanadium, and the remainder iron with the usual impurities. In making alloy steels for the purpose of the invention the ordinary ferro-niobium or ferro-tantalum alloys respectively to be found on the market may be employed without regard to the relative proportions of niobium and tantalum in these alloys. If pure tantalum metal or pure niobium metal should be employed for making the alloy steels, one of these metals may be used to the exclusion of the other, provided it is used within the limits given above for the sum of both alloy components. Generally the vanadium content will be between 1 and 2 per cent., but if a higher vanadium content is required it is desirable to select a higher carbon content within the range given above. Chromium may be added up to 6 per cent. and cobalt may be added for the purpose of improving the cutting power of the steels in amounts up to 20 per cent. It may also be of advantage to add small amounts of tungsten and/or molybdenum, in which case the total amount of these alloy components either singly or together must not exceed 5 per cent. The tantalum and niobium content given above may be replaced partially by a corresponding amount of titanium.—*June 23rd*, 1939.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Engineering and Marine Exhibition

Thursday to Saturday, Sept. 14th to 30th.—Olympia, London, W.6.

Institute of Metals

Tuesday to Friday, Sept. 5th to 8th.—Autumn meeting in Glasgow.

Institution of Electrical Engineers

Friday to Sunday, Sept. 15th to 17th.—TRANSMISSION SECTION. Summer visit to Yorkshire.

Institution of Mechanical Engineers

Saturday to Sunday, August 26th to October 1st.—American Summer meeting.

Iron and Steel Institute

Tuesday to Friday, Sept. 12th to 15th.—Autumn meeting in Cardiff.

PERSONAL AND BUSINESS ANNOUNCEMENTS

MR. JOHN HOLLOWAY, M. I. Mech. E., informs us that he has been appointed General Editor of the revised edition of "Workshop Practice" by Sir Isaac Pitman and Sons, Ltd.

HENRY BERRY AND CO., Ltd., inform us that their London Sales Office has been transferred to Abbey House, Victoria Street, London, S.W.1.

G. BEATON AND CO., Ltd., of Beatonson House, Victoria Road, Willesden, N.W.10, are acquiring the controlling interest in E-H. Fuel Injection, Ltd., of Harlequin Avenue, Brentford. It is intended immediately to increase the manufacturing facilities of the second-named company. Mr. Stuart C. Goodwin and Colonel Leslie Sadler are joining the board.

MR. COLIN CUNINGHAM SCOTT has been appointed chairman of Scott's Shipbuilding and Engineering Company, Ltd., Greenock. Mr. Scott, who has been a director of the company since 1916, is a cousin of the late Mr. R. L. Scott, and was formerly deputy chairman of the company. Mr. James Hammond Hoare-Scott, a nephew of the late Mr. R. L. Scott, has been appointed a director of the company.

CONTRACTS AND ORDERS

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

THE PARSONS ENGINEERING COMPANY, Ltd., Southampton, informs us that in connection with the recent Admiralty orders for a large number of 52ft. 6in. harbour service launches, twenty-two of the machinery sets will include Parsons reverse gears of the M type with pump lubrication.

LAUNCHES AND TRIAL TRIPS

HAV, motorship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of Helmer Staubo and Co. Dimensions, length 412ft. 3in., breadth 57ft. 5in., depth 38ft. Engines, four cylinder, Swan-Hunter-Doxford; launch, July 15th.

HOPERIDGE, motorship; built by Swan, Hunter and Wigham Richardson, Ltd., to the order of the Hopemount Shipping Company, Ltd.; dimensions, length 412ft. 3in., breadth 57ft. 3in., depth 38ft. Engines, opposed piston, two stroke, airless injection; launch, July 17th.

GLENGYLE, motorship; built by Caledon Shipbuilding and Engineering Company, Ltd., to the order of the Glen Line, Ltd.; dimensions, length 490ft., breadth 66ft., depth 38ft., gross tonnage 9000 tons. Engines supplied by Burmeister and Wain; launch, July 18th.

CATALOGUES

J. H. SANKEY AND SON, Ltd., Ilford.—New catalogue of refractories.

A. REYROLLE AND CO., Ltd., Hebburn-on-Tyne.—Pamphlet 1016 on Class U cartridge fuse links.

HERBERT MORRIS, Ltd., Loughborough.—Particulars of slings for a wide range of goods handling.

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—A new catalogue of materials for overhead power lines.

KEITH BLACKMAN, Ltd., Mill Mead Road, London, N.17.—Booklet V. 97 of smiths' hearths and blowing fans.

VISCO ENGINEERING COMPANY, Ltd., Stafford Road, Croydon.—Particulars of pressure-type air filters for compressed air pipe lines.

PETER BROTHERHOOD, Ltd., Peterborough.—A brochure giving a short history of the company and brief illustrated particulars of its products.